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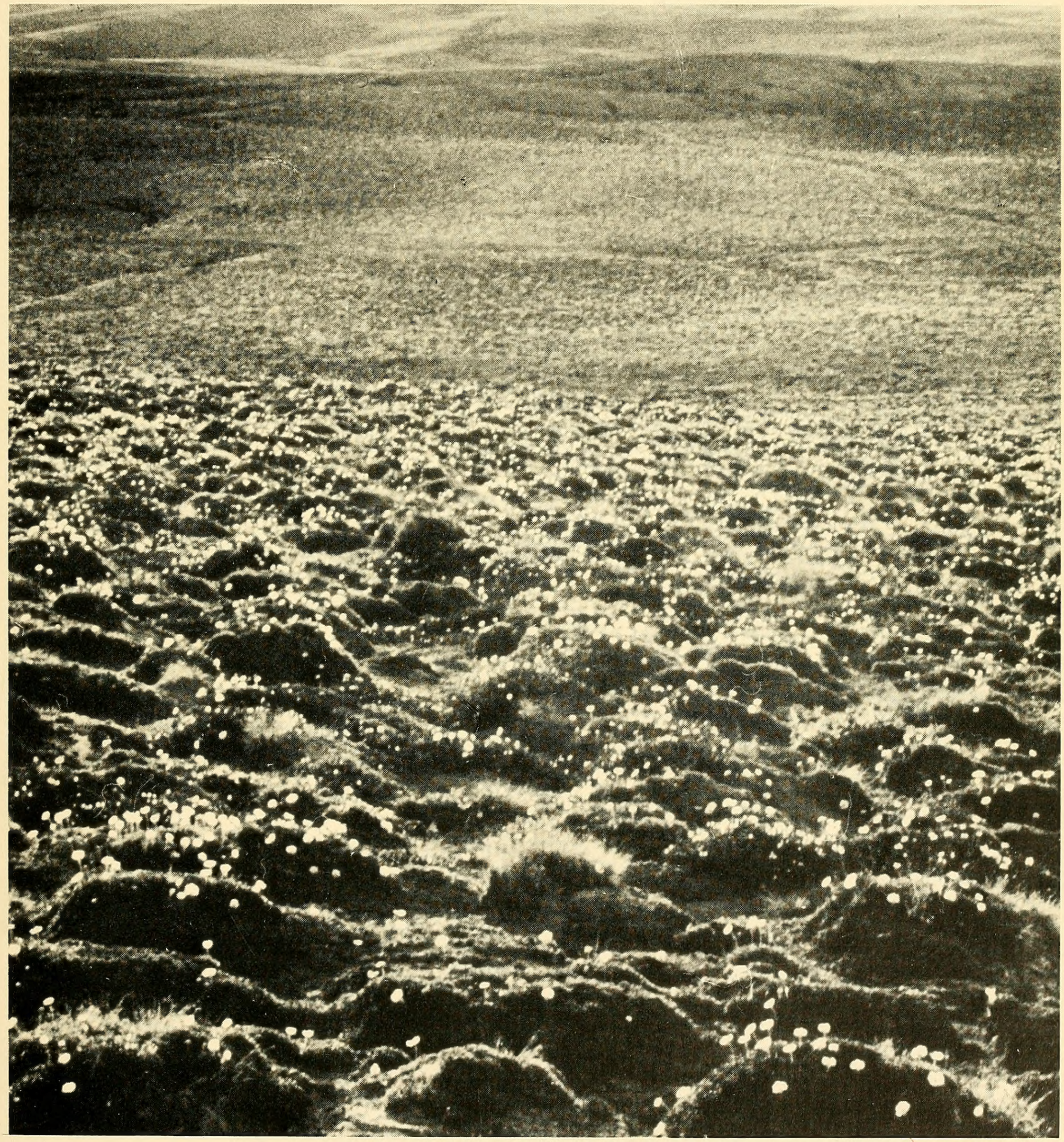

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The Ottawa Field-Naturalists' Club

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Their Excellencies the Governor General and Mrs. Roland Michener.

The objectives of the Club are to promote the appreciation, preservation and conservation of Canada's natural heritage; to encourage investigation and publish the results of research in all fields of natural history and to diffuse information on these fields as widely as possible; to co-operate with organizations engaged in preserving, maintaining or restoring quality environments for living things.

The Canadian Field-Naturalist

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Cover Photograph: Arctic flowers bending in the direction of the sun. See article entitled "Heliotropism in Arctic Flowers" by Peter G. Kevan, in this issue. Adapted from Kodachrome transparency.

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Mailing Date of this issue — April 5th, 1972.

Canada's National Parks: The Cutting Edge of Commercialization

The controversy raging over the proposed Village Lake Louise development (a tourist-attracting townsite in Banff National Park) is a controversy involving the fundamental purposes and policies for Canada's National Parks. National Parks Branch is faced on the one hand with strong pressures from private enterprise, resort-loving citizens, and tourist-seeking provinces. On the other hand it faces equally strong pressures from alarmed citizens who see Village Lake Louise as a move to exploit Banff National Park by appealing to citizens who would trade a magnificent cultural heritage for a resort-playground.

When, as in this case, different interests vie for conflicting types of park use, National Parks Branch requires a wise set of guidelines on which to base its decisions. Clearly, the issue must not be decided in favour of whichever faction shouts the loudest, or manoeuvres most skillfully behind the scenes. **The final decision in this controversy will affect our whole concept for our National Parks.** Each decision must be based on solid principles which have been agreed upon as a basis for parks policy. Most fortunately for Canadians, clear and wise guidelines have been laid down. We quote below from the document entitled *National Parks Policy,* issued by the National and Historic Parks Branch under the authority of the Honourable Jean Chrétien, Minister of Indian Affairs and Northern Development, (1969).

". . . Our National Parks system has as its basic purpose to preserve, for all time, outstanding areas and features as a national heritage. This statement represents the broad purpose of the system."

". . . The fundamental purpose of a National Park is comparable to that of a museum or art gallery."

". . . It is important that we recognize the basic purpose of National Parks as distinguished from the many secondary uses that have become established."

". . . The provision of urban type facilities is not part of the basic purpose of National Parks. Such recreation facilities, in harmony with the purpose and preservation of a park, may be introduced as required to meet recreational needs; but always so as to minimize impairment and not at all if substantial impairment is inevitable."

". . . our obligation to protect the areas from impairment implies not only protection against private exploitation, but also guarding against impairment by over-use, improper use and inappropriate development."

". . . A townsite should not be permitted to expand service and intertainment facilities to a point where visitors, who would not otherwise come to the park, are attracted."

". . . Several of the year-round as well as seasonally occupied townsites have gone far beyond minimum requirements in the directions listed above. These townsites have been developed to the extent that a very significant percentage of the visitors to the park come primarily to enjoy the developments within the townsite. This is contrary to the ideal established earlier . . ."

". . . In the interest of the taxpayer and the park user, and considering National Parks purposes, it is necessary to plan and guide the development of townsites so that they function primarily as Visitor Services Centres."

". . . A townsite is an intrusion. . . ."

National Parks Branch has served Canadians well in the preparation of this sound policy statement. Parks officials are now called upon to apply these principles when handing down rulings on the various proposals for Lake Louise. Indications are that National Parks Branch is being strongly tempted to depart

from its own policy statement in the case of Lake Louise. We draw the attention of Parks officials to the words of warning issued in their own policy statement . . . *"If it is to serve a worthwhile purpose as far as the planners and administrators are concerned, policies must have stability and continuity beyond the term of office of a government, the tenure of a particular group of senior officials, or the changing demands of commercial interests"*.

National Parks Branch, after considering thoughtfully all proposals for Lake Louise, must incorporate only those which are in harmony with National Parks Policy, and firmly reject the rest. No other course is acceptable.

Sheila C. Thomson

Spring Migration at Prince Edward Point, Ontario

RONALD D. WEIR
Dept. of Chemistry and Chemical Engineering, Royal Military College, Kingston, Ontario

Introduction

Since the mid-1960's, members of the Kingston Field Naturalists (K.F.N.) have undertaken trips to Prince Edward Point more often than previously. It is now known that the area is a major autumn migration route for passerines leaving Ontario (Quilliam and Cooke, 1968). The few trips made during April and May have indicated that sometimes the area is teeming with migrants. The lack of any detailed study of the point in spring prompted members of the K.F.N. to undertake this investigation.

Prince Edward Point (43°57′N, 76°54′W) is located at the eastern tip of the Long Point Peninsula, a part of the Quinte Peninsula, Prince Edward County, Ontario. The southern part of Prince Edward County is a headland and the position, therefore of Long Point running northeast is such that one might expect it to be an important landmark and stopping-off place for migrants crossing the lake. Various islands in the eastern end of Lake Ontario may also facilitate a lake crossing here. The width of the lake from Prince Edward County south to New York State is about 30-35 miles.

The objectives of our ornithological study at P.E.Pt. were as follows:

(1) To determine the importance of Long Point Peninsula as a stopping place for migrants in spring.

(2) To learn how the topography and vegetation influence the land migrants in their escape from the peninsula.

(3) To acquire a better understanding of the factors influencing the hawk migration at the northeastern end of Lake Ontario.

Part I summarises the general results of the study and Part II discusses the influence of weather during the period under review.

Methods

Our study was conducted daily for 50 days between April 9 and May 31, 1971 maintained by a roster system of two observers. On three days only was there no coverage: April 11, 13 and May 16. The starting point was located 51 miles from Kingston by road, 1½-hour drive, but the territory covered lay within a 30-mile radius of Kingston (see map).

Observations were made of diurnal populations along an assigned route. The route, of approximately five miles, was essentially defined by the only road that passed through wooded areas, orchards, fields, muddy and marshy areas as well as along the shores of Lake Ontario. Wooded areas along the road were searched on foot. Fields were inspected and telescopes used to scan Lake Ontario at approximately ¼-mile intervals. The areas near the lighthouse and around the south shore to Rocky Point were covered on foot. Numbers of all species seen, flight directions and any special activities of the birds seen were recorded. Weather and wind conditions were also noted. The starting times and total observing times are summarised in Tables 1 and 2.

The southern shore from Big Sand Bay to Rocky Point was not included in the route. Nocturnal observations were not made. Neither banding nor netting was carried out. One area to the west of the starting line designated PLOVER FIELDS was checked on the homeward journey for Black-bellied Plover and Golden Plover which are seen there in autumn. Information was also gained there of additional waves of birds and flight directions along these fields, particularly those of hawks.

The Canadian Meteorological Station at Kingston, Department of Transport, supplied

TABLE 1. — Starting times (within hours of sunrise).

	1 Hour	1-2 Hrs.	2+ Hrs.	Total days
April	20%	45%	35%	20
May	70%	16.7%	13.3%	30

TABLE 2. — Number of days as a function of observing hours during April and May

	Less than 3 hours	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-9.0
April	1*	4*	6	5	2	2	–
May	–	–	3*	3	9	7	8

*Weather factor.

synoptic weather maps of eastern North America and associated data at six-hourly intervals throughout the study period. Weather conditions, wind speed and direction at the Main Duck Island, five miles east of P.E.Pt. were also provided by them at six-hourly intervals. No major kills occurred at the lighthouses on Main Duck I. nor False Ducks I. in the study period.

PART I. PATTERNS OF MIGRATION

Results and Discussion

Abundance of Migrants

The eastern end of Lake Ontario lies between the Atlantic Flyway and the Mississippi Flyway. Birds from both flyways are found here but obviously their density will be much less than closer to either flyway. Diurnal observations will probably not give a true picture of the total volume of migration. Many nocturnal migrants will pass directly over. It has been found that the number of grounded migrants represents a variable proportion of the number flying overhead (Lack, 1960). It is impossible to determine the total number of birds in our relatively large survey area. However, because of the systematic method of the study, daily differences should have meaning and broad trends in population levels which appear should give a picture of migration in and out. The differences introduced by inclement observing weather were more easily dealt with than were differences due to observers. There are cases where it is impossible to know whether differences in numbers are statistically significant. Two hundred species including waterfowl were recorded during the study period.

Waterfowl. The main migration of several of the diving ducks occurs in the Kingston area during March, before our survey was begun. Accordingly results for this group are important only for the length of time that the earlier ducks spend in these offshore waters and the numbers of later-arriving ducks. Canada Geese *(Branta canadensis)* passed through in two separate time periods with 281 between April 9-21 and 4,806 between April 28 and May 9. Oldsquaw *(Clangula hyemalis)* was the most abundant species of duck. Their high number was 1,100 on May 6. Two of the scoters were recorded, their total numbers 313 and seven for White-winged *(Melanitta deglandi)* and Surf *(Melanitta perspicillata)* respectively.

Hawks. Eleven species of Falconiformes were found in migration, none of which was abundant by the standards of spring flights at Derby Hill, N.Y. Table 3 shows their distribution.

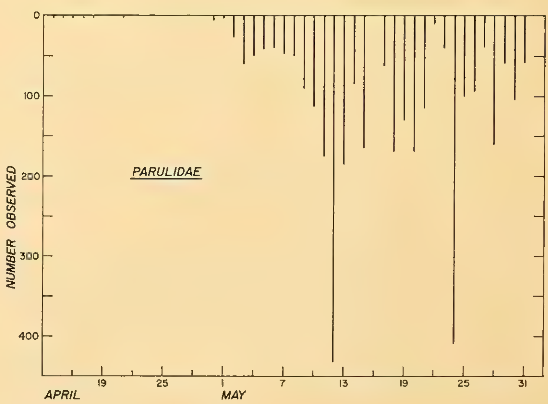
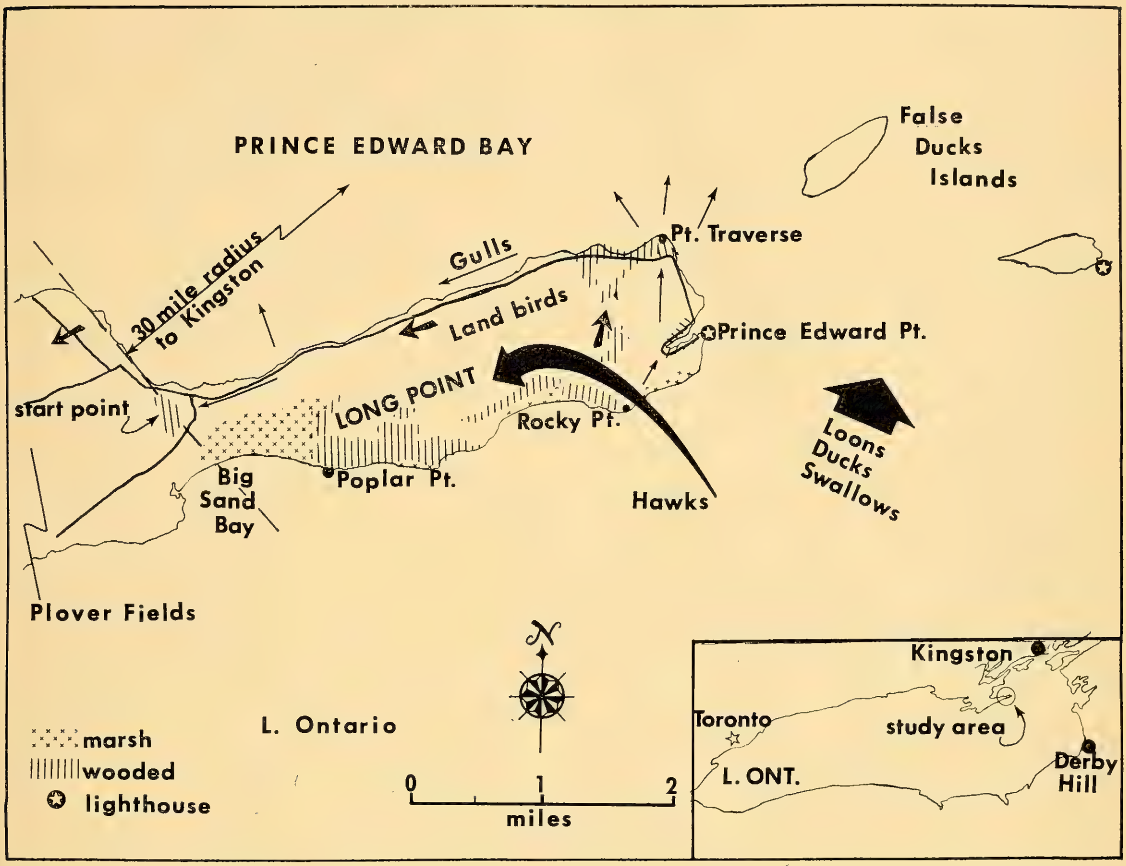


FIGURE 1. Daily numbers of parulidae.



Shorebirds. Their flight was a contracted one and although 18 species were recorded, the numbers of none were high. Spring occurrences in Ontario for several species are much less frequent than those in autumn and this was found to pertain at P.E.Pt. as well. Golden Plover *(Pluvialis dominica)*, well outnumbered by Black-bellied Plover *(Squatarola squatarola)*, were present on nine days between May 11 and 28. The Pectoral Sandpiper *(Erolia melanotos)*, Baird's Sandpiper *(Erolia bairdii)* and Sanderling *(Crocethia alba)* migrate west of Hudson's Bay in spring (Godfrey, 1966). Of this trio, only one Pectoral Sandpiper was identified, May 15.

Cuckoos were not recorded. They were also scarce in the immediate vicinity of Kingston during the migration period but since the series of Breeding Bird Surveys carried out in June showed normal numbers, it is possible that the late spring delayed their arrival to such a degree that they arrived in their breeding localities without stopping off en route. In past years they have been seen in spring and autumn at P.E.Pt.

Passerines. The density of the grounded passerine migrants along Long Point was found to be much higher than has been observed in areas near Kingston. There is evidence that funnelling takes place causing the piling up. Further discussion on this point is to be found in the section Flight Directions below. The numbers of grounded passerines as a result of the weather is given in Table 4. Their number was significantly higher on days associated with stormy weather or frontal passage.

TABLE 3. — Distribution of hawks.

	April 9–19	April 20–30	May 1–10	May 11–20	May 21–21	Total
Turkey Vulture *Cathartes aura*	0	1	2	1	2	6
Goshawk *Accipiter gentilis*	0	2	1	0	1	4
Sharp-shinned Hawk *Accipiter striatus*	0	2	16	3	0	21
Cooper's Hawk *Accipiter cooperii*	0	6	15	4	3	28
Red-tailed Hawk *Buteo jamaicensis*	8	13	22	14	7	64
Red-shouldered Hawk *Buteo lineatus*	1	0	2	7	0	10
Broad-winged Hawk *Buteo platypterus*	0	0	26	3	4	33
Rough-legged Hawk *Buteo lagopus*	3	3	6	1	0	13
Marsh Hawk *Circus cyaneus*	28	25	71	23	19	166
Osprey *Pandion halieatus*	0	1	4	2	0	7
Sparrow Hawk *Falco sparverius*	23	22	16	12	15	88
Accipiter (sp.)	0	0	4	2	0	6
Buteo (sp.)	6	10	24	19	0	59
Falcon (sp.)	1	0	3	0	0	4
	70	85	212	91	51	509

One pair of Marsh Hawks and of Sparrow Hawks may have been breeders in the area. No attempt was made to find a nest.

A comparison of the total numbers of birds of 45 selected species of passerines and one species of woodpecker is to be found in Table 5, column 7. The daily number of Parulidae is presented in Figure 1.

Flight Directions and Migration Routes within the Peninsula

Observations at P.E.Pt. by the Kingston Field Naturalists in previous years have shown that migrants use the peninsula regularly in both spring and autumn. It is here that many of the vagrants are found suggesting there is something special about its location and topographical influence. Major and minor flight directions are indicated on the map.

Loons and Waterfowl. The main Common Loon (*Gavia immer*) flights were observed between Rocky Point and the lighthouse, flying NE along the south shore and veering northwards between Swetman and Timber Islands and the peninsula. Some individuals moved northwards across Long Point as far west as the plover fields.

The flocks of Canada Geese were flying N or NE and heavy anywhere over Long Point. Some fed and rested in the fields. Waterfowl flight directions were more difficult to determine. Much local back and forth movement took place among the rafts and those which were migrating moved in the same flight path as the loons. Concentrations of ducks which were present in the afternoon of one day were sometimes completely absent at dawn on the following morning. This was especially noted of the Oldsquaw. Whether they are night migrants has not been observed by us but our records of diurnal fluctuations suggest that this may be the case.

Gulls. Their flight routes depended on the wind. Whereas many species did not fly in strong NW or N winds, the gulls did so, their heavy flights following both the north and south shorelines closely (see map). With light or favorable winds. they were seen flying well offshore, heading N or NE.

Hawks. The only entry point observed was the area between the lighthouse and Rocky Point and Poplar Point. Hawks were actually seen arriving from over the water. Telescopic observation did not pick them up until they were within two miles or so of the shore. Their direction was NW over the water until striking the land usually at treetop height. They flew along the peninsula westwards with some of the buteos and harriers flying north and northwest over Prince Edward Bay and heading NW through Prince Edward County.

There were 14 days on which a hawk migration took place, when their direction was discernible; 7 days when at least 9 birds were seen but no direction was indicated by observers; and 28 days when no significant movement was detected. The following were the wind conditions on the 14 migration days: 1 — SE 20 (knots); 5 — W to NW 15-25; 8 — W to SW 10-25. There was one day, April 30, when one Turkey Vulture *(Cathartes aura)*, one Goshawk *(Accipiter gentilis)*, two Cooper's Hawks *(Accipiter cooperii)* and two Red-tailed Hawks (*Buteo jamaicensis*) were seen moving together in front of an advancing thunderstorm approaching from the west, as if they were attempting to avoid it. The disturbance passed in 20 minutes but these hawks were not seen again.

Shorebirds. Although littoral in their passage, this group was usually found in the wet and muddy patches of the fields. The shoreline was either lacking or unsuitable because of the high water level. Common snipe (*Capella gallinago*) were seen landing after dawn on one occasion. These were clearly not engaged in courting flights. Two flocks of eight each landed in a wet field within a few moments of each other, dropping silently and suddenly out of the sky, April 25.

TABLE 4. — Numbers of grounded migrants* as a function of weather.

	Frontal passage stormy weather	Fair weather
Total birds	17216	12011
No. of censuses	22	26
Birds per census	783	462
Census hours	138	159
Birds per hour	125	75.5

Ratio of grounded migrants in stormy weather to fair weather. Birds per census 783/462 = 1.69
Birds per hour 125/75.5 = 1.66
*Columbidae to Fringillidae excluding Red-winged Blackbird, Common Grackle, Brown-headed Cowbird.

Landbirds. The behavior of this group provided some interesting facts about how and to what extent Long Point is used. It is convenient to divide these birds into two groups: 1. the blackbirds and jays; 2. doves to sparrows (on the taxonomic list).

Group 1. The flight direction of the blackbirds and jays was easily determined as they flew over the fields and along the roadside. They moved southwest along the north shore with heavy flights on 17 days. Invariably these occurred in the morning while they spent the afternoons in feeding. There was one morning when flocks of Blue Jays *(Cyanocitta cristata)* flew NE along the road piling up at Pt. Traverse and then flying back along the road in the direction from which they had come. None was seen flying out over the water.

Group 2. The flight direction of this group was not so obvious. On nine days, they were seen making their way SW along the north shore between wooded areas. There were 16 days on which observers noted no detectable movement and on these days birds were feeding industriously especially early in the morning. There was one day when some movement NE along the north shore was noted. On the remaining 24 days, observers made no comment on movement nor direction. It was at the NE end of the peninsula that large numbers of these

TABLE 5. — Data on selected grounded migrants at Prince Edward Point.

	First seen	1st Quartile	2nd Quartile	3rd Quartile	Last seen	Total no.	Birds per census
Yellow-bellied Sapsucker *Sphyrapicus varius*	Apr. 12	Apr 16	Apr 24	May 2	May 24	81	1.62
Brown Creeper *Certhia familiaris*	Apr 9	Apr 12	Apr 21	May 4	May 18	253	5.06
Winter Wren *Troglodytes troglodytes*	Apr 9	Apr 17	Apr 24	May 3	May 25	144	2.88
Hermit Thrush *Hylocichla guttata*	Apr 12	Apr 21	May 1	May 7	May 18	132	2.64
Swainson's Thrush *Hylocichla ustulata*	May 2	May 15	May 23	May 26	May 30	50	1.00
Gray-cheeked Thrush *Hylocichla minima*	May 11	—	—	May 25	May 27	15	0.30
Veery *Hylocichla fuscescens*	May 8	May 12	May 16	May 24	May 30	39	0.78
Golden-crowned Kinglet *Regulus satrapa*	Apr 9	Apr 12	Apr 23	Apr 30	May 19	236	4.72
Ruby-crowned Kinglet *Regulus calendula*	Apr 14	May 4	May 7	May 12	May 28	995	19.9
Yellow-throated Vireo *Vireo flavifrons*	May 12	—	—	—	May 19	2	0.04
Solitary Vireo *Vireo solitarius*	May 6	—	May 12	May 24	May 30	23	0.46
Philadelphia Vireo *Vireo philadelphicus*	May 10	—	May 24	—	May 31	14	0.28
Black-and-white Warbler *Mniotilta varia*	May 2	May 10	May 14	May 21	May 31	94	1.88
Golden-winged Warbler *Vermivora chrysoptera*	May 17	—	—	—	May 24	4	0.08
Blue-winged Warbler *Vermivora pinus*	May 19	—	—	—	May 19	1	0.02
Tennessee Warbler *Vermivora peregrina*	May 12	—	—	May 24	May 31	27	0.54
Orange-crowned Warbler *Vermivora celata*	May 18	—	—	—	May 19	2	0.04
Nashville Warbler *Vermivora ruficapilla*	May 4	—	May 12	May 18	May 30	157	3.14
Parula Warbler *Parula americana*	May 12	—	—	May 24	May 30	16	0.32
Magnolia Warbler *Dendroica magnolia*	May 13	—	—	May 24	May 31	266	5.32
Cape May Warbler *Dendroica tigrina*	May 11	—	May 18	May 20	May 30	52	1.04
Black-throated Blue Warbler *Dendroica caerulescens*	May 12	—	May 18	May 23	May 30	78	1.56
Myrtle Warbler *Dendroica coronata*	Apr 14	May 9	—	May 13	May 29	1077	21.5
Black-throated Green Warbler *Dendroica virens*	May 6	May 13	May 18	May 24	May 31	189	3.78
Cerulean Warbler *Dendroica cerulea*	May 17	—	—	—	May 17	1	0.02
Blackburnian Warbler *Dendroica fusca*	May 12	May 23	—	May 28	May 31	73	1.46
Chestnut-sided Warbler *Dendroica pennsylvanica*	May 12	May 20	May 24	May 28	May 31	87	1.74
Bay-breasted Warbler *Dendroica castanea*	May 18	—	—	May 25	May 31	75	1.50
Blackpoll Warbler *Dendroica striata*	May 19	—	—	May 29	May 31	24	0.48
Pine Warbler *Dendroica pinus*	Apr 30	—	—	—	May 24	5	0.10

TABLE 5. — (*Continued*)

	First seen	1st Quartile	2nd Quartile	3rd Quartile	Last seen	Total no.	Birds per census
Prairie Warbler *Dendroica discolor*	May 8	—	—	—	May 13	2	0.04
Palm Warbler *Dendroica palmarum*	May 2	May 8	May 11	May 15	May 25	31	0.62
Ovenbird *Seiurus aurocapillus*	May 4	May 17	May 20	May 24	May 28	33	0.66
Northern Waterthrush *Seiurus novaboracensis*	Apr 30	—	—	—	May 29	12	0.24
Mourning Warbler *Oporornis philadelphia*	May 15	—	—	—	May 31	3	0.06
Yellow-breasted Chat *Icteria virens*	May 12	—	—	—	May 19	6	0.12
Wilson's Warbler *Wilsonia pusilla*	May 19	May 22	—	May 27	May 31	60	1.20
Canada Warbler *Wilsonia canadensis*	May 19	—	—	May 29	May 31	45	0.90
American Redstart *Setophaga ruticilla*	May 9	May 20	May 24	May 26	May 31	162	3.24
Scarlet Tanager *Piranga olivacea*	May 14	May 18	—	May 25	May 31	44	0.88
Slate-colored Junco *Junco hyemalis*	Apr 9	Apr 20	Apr 24	May 2	May 28	1513	30.3
Oregon Junco *Junco oreganus*	Apr 17	—	—	—	Apr 28	5	0.10
White-crowned Sparrow *Zonotrichia leucophyrs*	Apr 29	May 11	—	May 15	May 29	330	6.60
White-throated Sparrow *Zonotrichia albicollis*	Apr 15	May 3	May 8	May 12	May 29	1713	34.3
Fox Sparrow *Passerella iliaca*	Apr 9	Apr 16	—	Apr 22	May 11	51	1.02
Lincoln's Sparrow *Melospiza lincolnii*	May 3	—	May 18	—	May 26	16	0.32

birds advanced from the south shore to the north shore along two routes. The greatest number passed through the wooded corridor consisting of deciduous trees and shrubs. The migrants crossed the road some turning to move SW along the shore but most piling up near Pt. Traverse, an excellent area for food and protection from wind. A lesser number made their way from the wooded areas near Rocky Pt. to the harbour, lighthouse area and the sheltered spots at Pt. Traverse. No birds were seen flying into the Pt. Traverse area from across the water on its N and NE. Some flights were seen leaving the area heading NW, W, and NE across the water but this occurred only with S or SW winds. Flights departing across the water from the north shore situated to the west of Pt. Traverse also occurred with S or SW winds. Our study permits only a qualitative assessment that more migrants seek the land route SW in daylight than fly directly north across the water from the north shore. The relative numbers involved are unknown.

Because observations were not made on the south shore nor in the early hours before dawn, it is unknown where the migrants land. Probably they strike wherever the wooded areas are found and large numbers are funnelled to the northeast area of Long Point where they accummulate.

Reverse Migration

A southward flight of small migrant birds occurs each spring from Point Pelee. This reverse migration phenomenon has attracted naturalists who have sought to discover why it

occurs. Gunn (1948, 1951) carried out a detailed analysis, the results of which show its explanation is not simple. The concentration and flight direction toward the south of those involved are accentuated by the topographical features of Point Pelee and Fishing Point which point southward.

The results of our study indicate that no significant reverse migration occurs from P.E.Pt. area. That its land mass lies northeast rather than a narrow piece of land stretching into the lake southwards may have some bearing on this problem. There is only one example of a bird, Eastern Kingbird *(Tyrannus tyrannus)*, May 12 at noon, flying SE from the shore near Rocky Pt. Winds were S, 20 knots, and the bird disappeared over the lake.

Timing of Migration

Falconiformes. A comparison of our hawk data with published information on the spring flights at Derby Hill, N.Y. (Haugh and Cade, 1966 and Rusk and Scheider, 1970, Rusk and Spies, 1971) shows some interesting features about the timing. Haugh and Cade show a schematic representation of the average number of hawks, their range and peak periods passing Derby Hill, based on observations for the springs of 1956 to 1963. At Derby Hill, Sharp-shinned Hawks, Broad-winged Hawks, and Osprey normally show well-defined peaks in April, sometimes late in the month. These three species were virtually absent at P.E.Pt. in April, Table 3. Nineteen of our 21 Sharp-shinned Hawk records occurred after May 3, and the first Broad-winged Hawk was not recorded until May 4. This species accounted for only 6.5% of our total hawks. In comparison 62% and 79% of the Derby Hill spring hawks in 1963 and 1964 respectively were Broad-winged Hawks.

Four other hawk species peaked at P.E.Pt. after early May which in all cases were outside their time range at Derby Hill. Twenty-two (79%) of our Cooper's Hawks passed after May 1 and seven of our ten Red-shouldered Hawks occurred on May 14. Practically all of this latter species go past Derby Hill by March 30 with a few stragglers into April! Red-tailed Hawks and Marsh Hawks also peaked after May 1. Because of the resident Marsh Hawks on Long Point, their case is not as clearcut. However, the 29 seen arriving on May 4 from over the lake is significant. By this date at Derby Hill, their flight is nearly ended. On the same day, May 4, as the Broad-winged Hawk flight of 17 birds at P.E.Pt., 49 Broad-winged Hawks were counted migrating NE from Kingston along the Rideau Canal. Four late birds of this species were migrating together at P.E.Pt. on May 28.

We have not seen Derby Hill 1971 data and so cannot check for an abnormally late migration there. There were four days during April when winds were S to SE (clear or broken cloud) at P.E.Pt. The best Derby Hill flights occur under these wind conditions yet only one of these four days was classified as a migration day at P.E.Pt.

Passerines. Weather during April and May, excepting the third week of May, was unseasonably cold with temperatures 10°F. to 15°F. below the 10-year normal values of daily maxima and minima. This accounts for the later than normal arrivals, both first arrivals and the main body of migrants. No passerines were seen at P.E.Pt. nor at Kingston before the earliest-ever Kingston records (Quilliam, 1965).

Tables 6 and 7 show comparisons of the first arrivals at Kingston and at P.E.Pt. in relation to the average first arrival date as given in Quilliam, 1965. There are significant differences between the two locations, only 26 miles apart. Observations in Kingston were made throughout the survey period but not on an organized basis.

Details of the migration timings of selected non-breeding transients are given in Table 5, the quartiles denoting that quarter of the total migrants which had gone through. There are several of the earlier spring migrants whose largest numbers passed through much later than is usual. Fifty per cent of the Hermit Thrushes and 25% of the Golden-crowned Kinglets moved through after May 1. White-throated Sparrows, the most common migrant, held back

with 75% of them seen after May 3. There are 14 transients in the table that were still arriving on May 31. It was after this date in Kingston that heavy flights of Red-eyed Vireos occurred, a common resident which until late May was unusually scarce. Cedar Waxwings *(Bombycilla cedrorum)* did not begin passing through until May 29. The flock of 150 Snow Buntings *(Plectrophenax nivalis)* on April 12 and two on April 18 were very late.

Late influxes of certain species, representatives of which are summer residents in the Kingston area, were noted. Blue Jay, Robin *(Turdus migratorius)*, Red-winged Blackbird *(Agelaius phoeniceus)*, Eastern Meadowlark *(Sturnella magna)*, Savannah Sparrow *(Passerculus sandwichensis)*, and Song Sparrow *(Melospiza melodia)* were continuing to arrive after representatives of these were known to be already on breeding territory and many of them nesting. These influxes occurred along with waves of transients at the times of passing cold fronts or grounding rains.

Blue Jays showed a peculiar pattern. Between April 18 and May 10 only one or two jays were always found in the same location, possible nesting birds. On May 11, 35 arrived only to disappear the following day. A second influx on May 18, 19, and 20 occurred with 40, 62, and 17 birds respectively. Jays had already begun nesting at Kingston. The migration of Blue Jays in autumn is much more conspicuous than the northward movement in spring (Bent 1946). This may account for the paucity of accounts dealing with spring migration of this species. They have been noted in detail at Lake Mendota, Madison, Wisconsin (Schorger, 1964) from April 24 through May 15, 1963 and at Whitefish Point, Michigan (Tyrell, 1934) as late as June 5, 1930.

Robins were unusually plentiful on April 21 (cold front) and April 30 (rain). Analyses of a great many counts of Robin populations in many parts of eastern North America have shown that the spring migration is not a continuous uninterrupted movement to the north but that southward shifts occur when cold snowy weather is encountered. (Speirs, 1956).

TABLE 6. — Comparison of 1st arrival dates with average Kingston 1st arrival date* (Quilliam, 1965).

	P.E.Pt. 1971	Kingston 1971
Shorebirds to and including finches 69 species	48% after avg.	62% after avg.
Vireos & warblers 30 species	60% after avg.	67% after avg.

*Species whose average Kingston arrival occurs within study period.

TABLE 7. — Fraction of 1st arrival dates within days shown of average Kingston 1st arrival date* (Quilliam, 1965).

	Days of avg. arr.	P.E.Pt. 1971	Kingston 1971
Shorebirds to and including finches 69 species	−4 to +4	74%	48%
	−2 to +2	51%	24%
Vireos and warblers 30 species	−4 to +4	87%	46%
	−2 to +2	60%	21%

*Species whose average Kingston arrival occurs within study period.

Eastern Meadowlarks showed appreciable increases on April 21 and May 12.

Male Red-winged Blackbirds in large numbers were seen migrating daily until about May 10. Prior to April 27, few females were identified but after this their numbers increased. On May 9, 300 females arrived near the lighthouse. By contrast in the Kingston marshes, the females were on territory by April 14. Bent (1958) summarises A. A. Allen's life history of the Red-winged Blackbird. At Ithaca, N.Y., it was found for the adults in spring migration that the migrant males preceded the resident males which were followed by migrant females and then the resident females. Immature birds were last to arrive.

Song Sparrows showed new peaks on April 16 and 30 with a late influx of Savannah Sparrows also occurring on the latter date. Both species nest north to James Bay and the Savannah even farther north (Godfrey, 1966).

General Discussion

The number of migrants observed on any one day was higher during the last five weeks than in the first two and one-half weeks. However, the number arrested with frontal passage or storms was in both periods higher than in fair weather (ratio 1.7). The snow and cold on April 24 impeded observations and the numbers on this day probably underestimate considerably the arrested wave. The actual census numbers for April 24 were included in the figures, Table 4. It is interesting to compare the hours of observation per census during each of these two types of weather conditions. In fair weather, the average was 6.12 hours per census while for stormy frontal passage, 6.27 hours per census were spent. The difference amounts to only nine minutes per census.

It is most likely that the hawk flights seen at P.E.Pt. came across the eastern end of Lake Ontario from N.Y. State. Their timing was such that all the major flights would have passed through Derby Hill. Perhaps these late raptors are in a hurry to get to the breeding grounds and a short water crossing is no deterrent. A crossing from the southeast corner of Lake Ontario would lie over a chain of islands directly to P.E.Pt. Such a span is 30 miles with Galoo, Main Duck, and False Ducks Islands en route. Since we have not made observations from any of these islands we may only assume that they follow this route. Marsh Hawks were the most numerous over-water fliers. They have often been seen in spring arriving at Wolfe and Amherst Islands near Kingston from across the lake. Generally buteos were later fliers in the day than accipiters, falcons, or harriers.

It is not wholly clear why hawk migrations were observed only on days with winds between SW and NW. Of the 14 significant migration days, only April 9 and May 7 had SE winds. There were 10 other days in May with SE winds but all were without a visible hawk migration. One would expect *a priori* the hawks using the water crossing to take advantage of favorable SE winds to enable them to fly very high across the water. It is well known that they rise to great heights on thermals. As they approach the south short of Lake Ont. in N.Y. State, the southerly light winds over land cause the raptors to soar to their greatest heights (Haugh and Cade, 1966). It may be that at such great heights, they are able to soar over the eastern end of the lake (and Derby Hill) virtually undetected. On days when head winds are encountered, the hawks would be unable to maintain altitude as they approach the Long Point Peninsula. The hawks on these head wind days were seen at treetop heights, flapping frequently in labored flight.

Summary

1. Large numbers of passerines are grounded in spring along Long Point. The geographical features of the peninsula causes funnelling of the grounded migrants and many accumulate at the northeastern end.

2. To escape by day from the peninsula, most birds follow the land route southwest along Long Point. Some do fly over the water from the north shore particularly with south or southwest winds.

3. The number of grounded passerines is significantly higher in stormy weather and weather associated with frontal passage than in fair weather.

4. The peninsula serves as a minor hawk route in late spring. The hawks arrive from over the lake flying northwest. Whether they leave N.Y. State from the southwest, the south, or the southeast is unknown but a chain of islands from the southeast corner of the lake would appear to be the most likely crossing route.

5. Small landbirds arrived at P.E.Pt. earlier than at Kingston although the unseasonably cold spring weather delayed first arrivals and the main body of migrants at both locations.

6. No significant reverse migration was observed at Long Point.

PART II: THE RELATION OF WEATHER TO SPRING MIGRATION AT PRINCE EDWARD POINT

Introduction

The influence of weather on migration has long been recognized by ornithologists working

TABLE 8. — Summary of all of the meteorological cycles involving depressions.

1. Cycle	2. Type	3. Warm front	4. Cold front	5*.	6.*	7. Wave classification	8. Notes
Apr 12–14	B	Apr 13	Apr 13	10P** 9K**	1	Arrested, Apr 13	Last flock of Snow Buntings, Apr 12
Apr 20–21	B	—	Apr 21	2P 2K	6	Arrested, Apr 21	Apr 22 – all 6 species signifcantly lower.
Apr 24–25	B	—	Apr 24	1P 3K	3	Arrested, Apr 24	Snow/rain; Red-necked Grebes (*Podiceps grisegena*) at Kingston.
Apr 28–30	A	— (center of low passed Apr 29)	—	8P 5K	14	Arrested, Apr 28–30	Canada Goose – large flocks passed before rain Apr 28.
May 2–4	A	— (Center of low passed May 2)	May 2	10P 5K	10	Arrested, May 2,3 Onrushing, May 4	Canada Goose – 5500 over Kingston, p.m., May 4. Hawk flight P.E.Pt., May 4. Longbilled Dowitcher (*Limnodromus scolopaceus*), Kingston, May 5.
May 7–9	A	— (center of low passed just south of P.E.Pt. May 8; light rain/fog warm)	—	24P 7K	4	Onrushing May 6, 7 and 9 Arrested May 8	Canada Goose – large flocks passed before rain May 7. Emigration of Oldsquaw overnight May 6. Loon migration May 9.
May 11–14	A	well to N (very warm southerly air)	May 12	23P 16K	20	Onrushing May 10, 11,13,14. Arrested May 12	Last dates: Horned Grebe (*Podiceps auritus*), Greater Yellowlegs (*Totanus melanoleucus*), Fox Sparrow. Numbers of 22 migrants fell significantly overnight May 13–14 on SW and S winds.
May 18–21	A	— (air very warm until cold front passed)	May 19	24P 10K	13	Onrushing May 17, 18 Arrested May 19 ? May 20,21	Last dates for 7 species. Glossy Ibis (*Plegadis falcinellus*), Blue-winged Warbler, May 19. Orchard Oriole (*Icterus spurius*) present May 20.
May 23–25	A	— (center of low passed just south of P.E.Pt.	—	— —	28	Onrushing	Vireos & warblers in large numbers rushing onwards in front of rain.
June 2–3	—	June 2	June 3	— Total 102P 55K	—	—	Large numbers of Red-eyed Vireos (*Vireo olivaceus*) grounded at Kingston.

*Column 5 – No. of 1st arrival species. **P = Prince Edward Point K = Kingston
*Column 6 – No. of previously arrived species which significantly increased.

separately in Europe and in North America. Several reviews of the subject have been published. Our study at Prince Edward Point was primarily carried out in order to determine the importance of that area and how migrants use the peninsula in spring. The survey, described in the preceding pages and hereafter called Part I, was a daily census of the grounded migrants. Consequently there are limitations in using it to analyse the effects of weather on

the volume of bird migration since the number of grounded migrants may or may not be proportional to the number passing overhead (Lack, 1960). Nevertheless the method does permit some deductions to be made. The other two techniques frequently used to study volume of migration, thus permitting a correlation with the weather, also suffer drawbacks. The counting of night migrants crossing the face of the moon depends on clear, moonlit nights. Radar does not allow species identification and only those birds flying low can be detected (Lack, 1959).

The purpose of this article is twofold. It is an analysis of the weather patterns affecting spring migration in eastern Ontario allowing a comparison with published findings in New England (Bagg, 1948), in southern Ontario (Gunn, 1958) and at Madison, Wisconsin (Curtis, 1969). It also makes our data available for any future analysis of the spring 1971 migration along a broad front (Richardson, 1966). It is convenient to adopt the two types of migration waves defined by Bagg *et al* (1950) and apply these to the P.E.Pt. data. The *arrested* wave is one stopped by unsuitable weather and the *onrushing* wave is advancing with favorable weather. It is not an easy matter to distinguish the two types when migrants are on the ground but there are some clear-cut examples in our study. These will be outlined together with associated weather patterns.

Results and Discussion

A search of the literature on the effects of weather on spring migration in eastern North America shows that significant migration occurs in the warm sector of a low pressure area. The meteorological cycle associated with this is usually characterized by a high pressure area, clockwise rotation, moving away towards the east being replaced by a low pressure area, counter-clockwise rotation, from the southwest. The circulation of air between the two air masses is reinforced resulting in southerly moist tropical air being swept northwards. Bagg *et al* (1950) state that pronounced movement will take place into or through a given region during the interval between the passage of a warm front through that region and the subsequent arrival of a cold front. The cold front advancing from the west, often accompanied by rain, causes the migrating birds to ground until favorable weather again permits a resumption of their flight. This type of meteorological cycle occurred on six occasions during the study period at P.E.Pt. and is called type A. However, there were three other periods when the area was influenced by depressions which could not be described as above. Generally, these cycles were more complex, the common factor in all three being the formation and approach of the low from areas north to northwest of Kingston. These are called type B. They occurred in the early part of the study period and the warm sectors contained relatively cold air derived from arctic or polar regions.

A summary of all of the meteorological cycles involving depressions is given in Table 8 where it is seen that newly arrived species or an influx of previously arrived species is associated with each depression. It should be noted that the effects of a depression approaching Lake Erie on April 17 were not visible at P. E. Pt. This low moved southeast from Lake Erie very quickly and not even the associated cloud was seen at the eastern end of Lake Ontario which was coming under the influence of a high advancing from the northwest. There were neither new arrivals nor influxes at P.E.Pt.

General Discussion

There were nine meteorological cycles at P.E.Pt. in which a high was replaced by a low and this in turn was succeeded by another high. Altogether, the first arrivals of 102 species are directly tied to these disturbances. The waterfowl migration was well advanced at the outset of the study. Of those species between Chimney Swift *(Chaetura pelagica)* and Snow Bunting, on the taxonomic list, 117 were recorded. Twenty-nine of these were either sedentary or had arrived before the study period. Eighty of the remaining 88 have their first arrival date during one of these nine cycles. Of the nonconforming eight, three occurred between May

15-17, when single individuals were seen: Indigo Bunting *(Passerina cyanea)*, Mourning Warbler, Rufous-sided Towhee *(Pipilo erythrophthalmus)*. The other five species were Raven *(Corvus corax)* (1), Cedar Waxwing on May 29, Cardinal *(Richmondena cardinalis)* (1), Dickcissel *(Spiza americana)*, Oregon Junco.

The arrival of the main body of migrants also shows correlation with warm air. The higher the temperature, the more spectacular was the number of grounded migrants when a cold front intersected their line of flight. As the weather improved and winds became southerly, large numbers continued their northward flight. We have insufficient data on the hawks to say much more than that outlined in Part I. All the Turkey Vultures and 92% of the accipiters were associated with the nine cycles. Most of the accipiters passed after the disturbance as the leading edge of the high approached but this may not be statistically meaningful. Shorebirds conformed with the pattern of landbirds but so few records were obtained that no conclusions can be made for them. The Canada Goose flights preceded the warm front and were greatest on southeast winds. Emigration of Oldsquaw also occurred under these conditions.

There are examples of a significant decrease in a number of species on the day following a cold front passage when winds were from the NW. There could have been a reverse migration but it is more probable that the migrants escaped the peninsula by the land route described in Part I and advanced a few miles northward. In either case, they are not an onrushing wave.

Three of the species recorded on May 19 and 20 were accidental within a 30-mile radius of Kingston: Glossy Ibis, Blue-winged Warbler, Orchard Oriole. The very warm southerly air during the preceding week probably brought them into eastern Ontario. Their presence at P.E.Pt. coincided with the passage of a cold front May 19 and perhaps marked their retreat further south.

Migration studies by Richardson (1966) indicate that cloudy weather is less favorable than clear weather to migration. The cloud cover as a determinant of migration volume is of secondary importance. Indeed, influxes of migrants at P.E.Pt. did occur after overnight cloud (either broken or complete) coinciding with leading cloud cover of an advancing depression.

Summary

This paper correlates the results of the study of spring migration at P.E.Pt. and at Kingston with the weather in eastern Ontario between April 9 and May 31, 1971. Nine meteorological cycles occurred in which a high was replaced by a depression and this in turn succeeded by another high. A description of each is tabulated together with the number of species which staged an accompanying influx.

Bird migration into eastern Ontario is stimulated by the warm southerly flow of air associated with approaching low pressure areas, the same conditions which occur with migration along Lake Erie and into New England. First arrivals of 102 species and influxes of 99 species were recorded in the warm sector of the depressions. The grounding of migrants occurred in fog and rain and was dramatic with the passage of a cold front. Insufficient data on the hawks and owls were collected to include these families in the above pattern of migration.

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Food Habits of Black Bears in Interior Alaska

DAVID F. HATLER[1]

Dept. of Wildlife Management,
University of Alaska, College, Alaska

Abstract. Black bears in the interior of Alaska, emerging from winter dens in early May, spend much of the first three months of their annual activity season in riverbottom and other lowland situations where the shoots and new leaves of green vegetation, especially *Equisetum* spp. compose the bulk of their diet. From the last half of July until mid-September, bears are observed most commonly in alpine areas where fruits, especially *Vaccinium uliginosum*, are heavily used. Animal food, constituting less than 15 per cent of the annual diet, is apparently taken whenever it is obtainable, and is frequently carrion. Many animal food occurrences involve colonial insects. Due to characteristics of bear feeding and digestion, scat analysis appears quite reliable for frequency of occurrence data and is probably suitable for most basic food habits determinations. For studies in which emphasis is to be placed on the animal foods of bears, a series of stomachs may also be needed to insure proper interpretation of results.

Introduction

During the summer of 1963, an epidemic of black bear (*Ursus americanus*) problems in interior Alaska attracted considerable public attention. These problems, which included a much higher than normal incidence of camp-raiding and cabin break-ins by bears, culminated in five allegedly unprovoked attacks on humans. Though many people felt that a poor crop of blueberries (a known bear food) was responsible, local biologists were reluctant to commit themselves to explanations because of a recognized lack of evidence. As one unpublished report stated, "Unfortunately, very little is known of the food habits of black bears in interior Alaska . . ." Thus, the main purpose of this paper is to report on the basic food habits patterns of the black bear at what is essentially the northern edge of its range.

Also, since most ursid food habits work reported previously has relied heavily upon the analysis of fecal material for data, it seemed desirable to investigate the utility and reliability of this technique. My experience in analyzing the contents of stomachs and intestines, as well as scats, provides a basis for judgment on this subject, and my findings are presented in the concluding section of this paper.

[1]Present Address: Dept. of Zoology, University of British Columbia, Vancouver 8, B.C.

The Study Area

Food habits data were collected in the five areas designated in Figure 1. Due to the relative simplicity and homogeneity of the floral and faunal assemblage at these latitudes, my sample is very likely representative of the entire 38,000 km^2 unshaded area shown, and probably for adjacent areas of Canada as well.

Much of the area actually studied is occupied by the low, rolling hills of the Yukon-Tanana upland. These hills, few of which rise above 1,220 m in elevation, extend from Canada west to the confluence of the Yukon and Tanana Rivers, thus separating the drainages of these two large interior Alaskan waterways. The basins of the Yukon and the Tanana consist of wide flood plains marked by numerous meandering streams, ponds, and marshes.

The climate of this region is described as strongly continental by Watson (1959). Extreme temperatures and low precipitation are the rule. The highest temperature on record in the area is 100° F (37.8° C) at Fort Yukon (6-27-1915). The record low in the area, also at Fort Yukon, is —75° F (—59.4° C), only slightly warmer than the all-time Alaskan low of —76° F (—60° C) at Tanana in January of 1886. Mean annual precipitation in the area varies locally from less than 25 cm to about 40 cm while snowfall averages 1 to 1.5 m. The frost-free season is very short, beginning in late May and ending in late August in the lowlands. One result of these climatic features is that the black bears of interior Alaska usually spend six and one-half to seven months of each year in their winter dens. (Hatler, 1967).

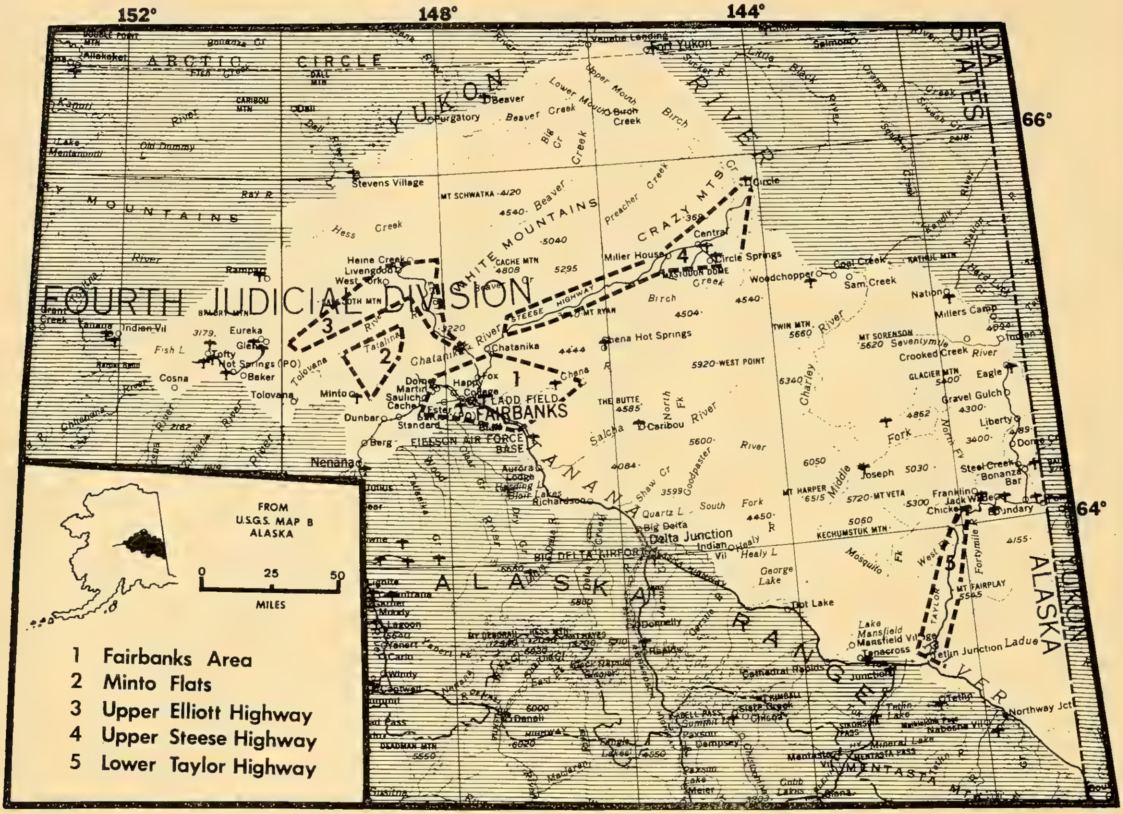

FIGURE 1. Map showing the five areas in interior Alaska from which black bear food habits sample units were collected.

Though interior Alaska is arid in terms of total precipitation, a variety of circumstances combine to hold much of the available moisture at or near the ground surface. Among these, as discussed by Drury (1952), are poor surface drainage due to the flat surfaces of the lowlands and gentle slopes of adjoining uplands, poor percolation through the fine-grained alluvial and wind-blown deposits which cover much of the region, and retarded sub-surface percolation over the permafrost (perennially frozen ground), which lies at varying depths under all but a few favorably exposed sites. Spongy vegetation, consisting largely of mosses, is common at the soil surface, and its water-holding and insulating characteristics serve to increase the effects of the phenomena already mentioned. A detailed treatment of soil types in the area, particularly as they relate to forest types, is given by Wilde and Krause (1960).

Table 1 lists the major vegetation types on the study area as determined by Buckley and Libby (1957). Coniferous forests occupy nearly 60 percent of the total forest area. About three-fourths of this is white spruce (*Picea glauca*) forest which, with its usual understory of alder (*Alnus* spp.) or willow (*Salix* spp.) and its ground cover of mosses, is apparently of little importance as feeding habitat for black bears.

Most of the remaining one-fourth of the coniferous forest area occurs on poorly-drained areas, including muskeg, and is characterized by sparse stands of black spruce (*Picea mariana*) and some larch (*Larix laricina*). With

TABLE 1. — Abundance of major environmental types in the study area. (After Buckley and Libby, 1957)[1]

Type	Number of Plots	Percent of Total Plots
Forest	1,281	66.61
Tall Brush	140	7.28
Dwarf Brush	259	13.47
Herb	137	7.12
Aquatic	53	2.76
Bare	53	2.76
Total	1,923	100.00

[1]The unshaded area shown in Figure 1 composes approximately the southern one-half of the area represented in the above sampling. It is probable that the forest category would occupy a somewhat larger portion of my study area than it does of the total area represented in this table, and the other types would be correspondingly smaller.

blueberry (*Vaccinium uliginosum*) common on the forest floor, this type is fairly important to bears, especially in early fall.

About 10 percent of the forest area is deciduous forest composed of white birch (*Betula resinifera*), aspen (*Populus tremuloides*), some cottonwood (*Populus tacamahacca*) and various mixtures of these species. Occurring on well-drained sites, often on south-facing slopes, the deciduous type supports a number of species on the forest floor which are important to bears, notably lowbush cranberry (*Vaccinium vitis-idea*), highbush cranberry (*Viburnum edule*), rose (*Rosa acicularis*) and horsetails (*Equisetum arvense, E. pratense,* and *E. sylvaticum*).

Mixed forest, largely white spruce-white birch and white spruce-aspen, makes up about 20 percent of the total forest area. Many of the items important to bears mentioned above, including highbush cranberry, rose, and horsetails, also occur in this type, though to a lesser extent.

The remaining forest area has been burned recently and now supports, largely, willows, alders, and dwarf birch (*Betula glandulosa*). Fireweed (*Epilobium angustifolium*) is the most abundant herb in the burns. Many of the older burns produce excellent crops of blueberries and are much used by bears in the fall.

Tall brush, consisting of shrubby growth 2.5 feet or more in height, occurs mainly at the lower elevations and particularly on alluvial sites and in riparian situations. It is an important cover type for bears in spring and early summer, when they are using streamside vegetation such as horsetails and some of the Graminoids. Willows, alders, and saplings of aspen, cottonwood, and birch are common components of this type.

Some of the same species of shrubs, growing in less favorable (frequently higher elevation) situations, compose the dwarf brush type (shrub growth less than 2.5 feet high). In addition, this type supports many heaths such as Labrador tea (*Ledum* spp.), blueberry, lowbush cranberry, and crowberry (*Empetrum nigrum*). Occurring mostly at elevations above 765 m. this type is particularly important to bears during the berry season.

The herb environmental type includes marshes, meadows, and alpine tundra. Sedges, particularly *Carex* spp. and *Eriophorum* spp., dominate in marsh and wet tundra situations with the horsetails *Equisetum limosum* and *E. palustre* locally important in some of the marshes. In meadows, which occur mainly on alluvial sites, sedges give way to grasses, especially bluejoint (*Calamagrostis canadensis*). Dry alpine tundra is characterized by sedges, alpine bearberry (*Arctostaphylos alpina*), lichens, and mountain avens (*Dryas* spp.). This well-drained to arid alpine situation comprises nearly 75 percent of the total herb type. Wet alpine tundra occurs in about 15 percent of the herb type, and the remainder is divided fairly evenly between marshes and meadows. These last two sub-types, particularly marshes, are the herb types most used by black bears.

Aquatic sites include all open water whether stream, river, lake or pond. Sub-surface vegetation is not considered. With respect to water, it should be mentioned that though salmon (*Oncorhynchus* spp.) and sheefish (*Stenodus leucichthys*) do reach waters of the study area in their inland migrations, in most years they are relatively few in number and are not readily available to bears.

TABLE 2. — Temporal and spatial distribution of black bear food habits specimen material, 1964-1965, interior Alaska.

Location	Specimen[1]	Spring			Fall			Total for area
		1964	1965	Total	1964	1965	Total	
Fairbanks Area	ST	1	1	2	3	1	4	6
	IN	1	0	1	3	0	3	4
	SC	0	1	1	5	0	5	6
Minto Flats	ST	0	2	2	0	0	0	2
	IN	0	1	1	0	0	0	1
	SC	0	0	0	0	0	0	0
Upper	ST	2	2	4	2	1	3	7
Elliot	IN	1	1	2	2	1	3	5
Highway	SC	1	1	2	7	3	10	12
Upper	ST	0	2	2	3	1	4	6
Steese	IN	0	2	2	1	1	2	4
Highway	SC	0	10	10	8	5	13	23
Lower	ST	0	2	2	0	0	0	2
Taylor	IN	0	2	2	0	0	0	2
Highway	SC	3	0	3	0	0	0	3
Totals	ST	3	9	12	8	3	11	23
All	IN	2	6	8	6	2	8	16
Areas	SC	4	12	16	20	8	28	44

[1]Specimen: stomachs (ST), intestines (IN), and scats (SC).

Bare sites, those devoid of vegetation, occur at all elevations, although the greater proportion lie above 1,000 m. They include talus slopes, rock outcrops, permanent snow banks, and newly established river bars.

Overall, as pointed out by Lutz (1956), the pattern of forest and vegetation in interior Alaska is a complex mosaic of types, with exposure, elevation, extent of drainage, and fire among the factors contributing to the pattern. The area, as black bear habitat, contrasts greatly with most other areas in its wetness of ground despite low precipitation, its relatively simple plant associations, its comparatively short snow-free season and in its lack of great runs of fish.

Materials and Methods

The specimen material used in this study includes 23 stomachs, 16 intestinal tracts, and 44 scats collected during the periods of bear activity (essentially early May through early October) of 1964 and 1965. In the interior of Alaska, the annual activity period is characterized by two general seasons of plant food availability. During the first, which begins when the bears emerge from their winter dens and ends in mid-July when fruits are beginning to ripen, green vegetation is the most abundant, potential food material. This entire season (arbitrarily, through 15 July) will be designated as "spring" throughout this paper. The second season, designated as "fall" in this paper, begins during the second half of July and continues until the bears once again retire for the winter. Obviously, this is the period during which fruit is the important food. The specimen material enumerated above is divided very nearly equally between spring and fall, as shown in Table 2.

Field Techniques. Stomachs and intestinal tracts were obtained from bears killed by hunters and, in three instances, from bears collected by the author. The loss of seven intestinal tracts was attributable to the activities of bird and mammal scavengers in three cases and to logistics in four cases.

After removal of the alimentary tract from the animal, the stomach and intestines were separated at the pyloric connection, wrapped separately in cheesecloth, and preserved in 10 percent formalin. Because bears commonly chew and swallow vegetation and debris while dying from gunshot wounds, the entire esophagus was always discarded.

Scats were collected only if they could be fairly confidently dated. This included those which retained sufficient moisture to be obviously fresh and those which had been deposited in a given area less than 10 days after an earlier visit I had made to the area. To prevent over-representation of any one time or place, multiple finds (for example the 11 scats found within an area of less than 50 m diameter in one instance) are treated as one scat. It wasn't possible, in many cases, to determine with certainty that scats had been deposited by black bears and not by grizzly bears (*Ursus arctos*). However, grizzlies were not common in any of the areas in which I worked; I saw none, and I saw definite sign (tracks) only once. I am confident that most, if not all, of the scats in my sample are black bear scats.

The first seven scats collected were oven-dried and stored in cheesecloth. All others were put into plastic bags, covered with isopropyl alcohol, and stored in glass jars. Scats handled by the latter method proved somewhat more convenient to work with, but not sufficiently so to warrant the extra expenditure of resources.

Laboratory Techniques. Stomach contents were washed in cold water, pressed and drained on 1/16 inch mesh screen, and spread out to a depth of about 15 mm on flat pans for analysis. Whenever feasible, individual items were separated out completely. Otherwise, separation continued until a homogeneous appearing matrix remained. When possible, five 50 cc samples were then taken from this matrix for further analysis; for a few stomachs containing small total volumes, the sample size was reduced to 25 or 30 cc, and the number of samples was reduced in some cases.

Samples were floated in 5 to 10 cm of water and again items were segregated as completely as possible. After separation, all items were measured volumetrically in graduated cylinders. When more than one green vegetation item occurred in the same stomach, complete segregation even in the samples was rarely feasible. In these cases, an ocular estimate of the relative amounts of each item in the green portion was necessary. Total stomach volume was taken as the sum of the volumes of the individual items separated out, the samples, and the remaining matrix.

Intestinal contents were washed vigorously under a strong jet of water to loosen seeds, bone, and other dense items which subsequently sank to the bottom of the container. These were examined and identified. The remaining lighter materials were decanted, drained, and spread out in much the same manner as were stomach contents, and these materials were then searched until it was believed that all items had been identified. Finally, a percentage volume was assigned to each item by ocular estimate.

Procedures for scat analysis were exactly the same as those for analysis of intestinal contents except that, to make my work directly comparable to that of Tisch (1961), volume estimates were limited to six categories: trace (less than 1 percent), 1-5 percent, 6-25 percent, 26-50 percent, 51-75 percent, and 76-100 percent.

Most examination and separation of materials was done macroscopically. Occasionally a binocular dissecting microscope was used to aid in volume estimates of finely ground vegetation and in identification of berries and seeds. The binocular microscope was used extensively in identification of green vegetation items. A compound microscope at low power was used in a few cases to aid in identification of hairs.

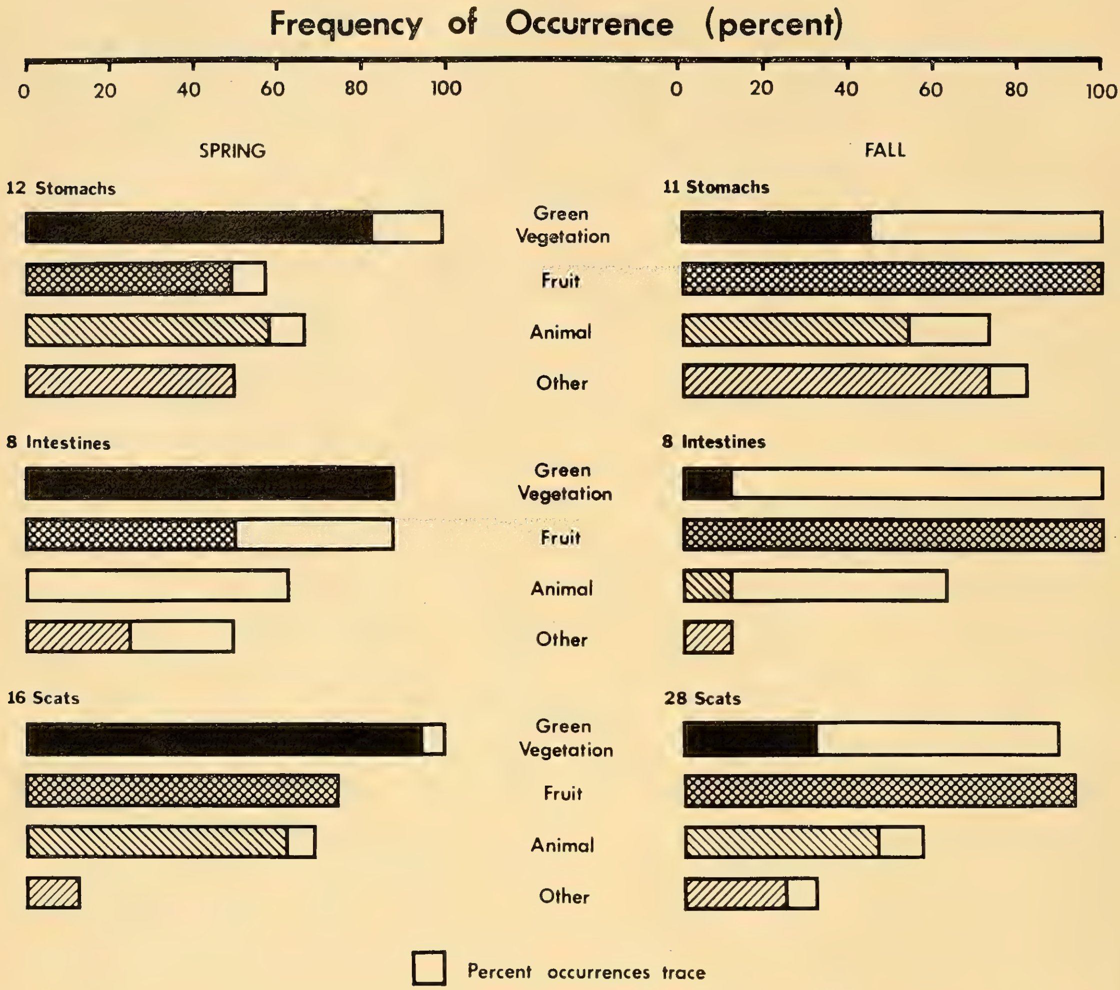

FIGURE 2. Frequency of occurrence of major black bear food materials in interior Alaska, 1964-65. The proportion of all occurrences which were at the trace level only is depicted visually for each food category. The associated numerical values, expressed as a percentage of the occurrences for each category, are listed in Table 3. The actual frequencies of trace occurrences may be read directly from the scale shown.

Identifications were verified by comparison with collections made during the field seasons in the case of fruits, comparison with reference specimens from the University of Alaska Museum in the case of mammals and birds, and comparison with pressed specimens from the University of Alaska Herbarium and consultation with local botanists in the case of green vegetation.

Results

Figures 2 and 3 depict the relative importance of major food categories by frequency of occurrence and by aggregate percentage volume respectively during each of two seasons of bear activity. Table 3 provides a seasonal comparison of frequency and quantitative information for individual food items found in stomachs, intestines and scats. Table 4, a list of trace

items with low frequencies of occurrence, supplements Table 3.

Green Vegetation. Green plant material proved to be, by far, the most important component of the spring diet of black bears in interior Alaska. Various unidentified grasses (*Gramineae*) were common, and the shoots and succulent stems of wild rhubarb (*Polygonum alaskanum*), and the young stems and leaves of northern bedstraw (*Galium boreale*) and lousewort (*Pedicularis spp.*) occurred occasionally. But horsetails, present in 86 percent of the spring sample units and representing a large proportion of the total contents, composed the real staple during this season. The largest stomach examined contained nearly 5 liters of shoots and young stems from the swamp horsetail (*Equisetum limosum*). The bear involved, a large male, was standing in about 50 cm of water feeding on this emergent plant when shot. A number of reports of other bears standing belly-deep in swamp water "feeding like moose," indicates that this was not an exceptional case. *E. limosum* was identified in the digestive tracts of two bears and in one scat, all collected in May, and composed 90 percent or more, by volume, of each occurrence.

All other occurrences of *Equisetum* were from samples collected in non-marsh situations and involved the common horsetail *(E. arvense)* or the meadow horsetail (*E. pratense*) or both. Distinction between these two species among the food habits material could not be made with certainty. However, on the basis of silica spicule characteristics as described in Fernald (1950), approximately 50 percent of these occurrences probably involved the former only, and the rest involved either or both. This *E. arvense-pratense* complex, then, comprised the most used spring food and it continued to be important through the first two or three weeks of the fall season. The leaves of arctic lupine (*Lupinus arcticus*) proved to be the only other green item of even minor importance in the fall.

A number of items such as the leaves of Labrador tea (*Ledum decumbens*), dwarf birch, and willow, and the needles of spruce had high frequencies of occurrence, particularly in the fall, but nearly always occurred at the trace level. These are believed to have been ingested incidentally to other foods, especially berries.

Fruits. Among the various fruits available in interior Alaska, two species of Vaccinium (blueberry and lowbush cranberry) are the most important to bears. Blueberries, when they are available, seem to be by far the most important food as evidenced by the fact that they were found in the digestive tracts of all fall bear specimens examined and occurred in nearly 80 percent of the scats collected during the fall period. Cranberries, which frequently remain on the vine overwinter, contribute much to the spring diet in some areas and become important again in late fall, especially after the first few frosts. (Freezing effectively reduces the availability of blueberries and probably increases the sugar content of the cranberries themselves.) In some areas, particularly in forested lowlands, the fruits of rose (*Rosa acicularis*) and, to a lesser extent, highbush cranberries are taken consistently toward the end of the fall season. Crowberry shows its greatest importance in late fall, but good patches of overwintered berries may receive heavy use in the spring.

Animal. Most vertebrate material reported here appeared to be carion. Snowshoe hare (*Lepus americanus*), the most common item in this category, was found throughout both seasons but seemed to be slightly more important in the spring. Hind feet and pieces of hide are the most persistent remains of hares killed by small carnivores and raptors, and these were the *Lepus* parts involved in most occurrences. The only large volume of moose (*Alces alces*) meat found in this study contained hundreds of maggots, thus attesting to its carrion nature. Other moose occurrences were suspected carrion because of the nature of the material found (e.g., small pieces of hide and hair) in some cases and proximity of specimen collection

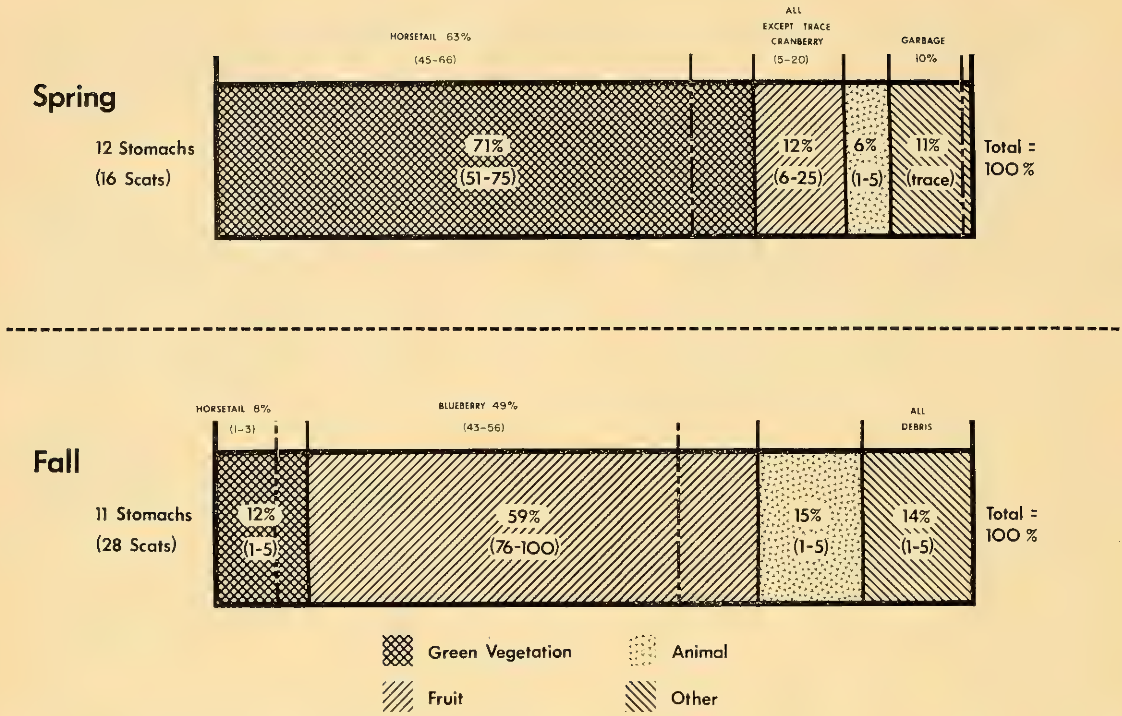

FIGURE 3. Aggregate percent volume occupied by each of four main food categories in the diets of interior Alaskan black bears, 1964-65, as revealed by analysis of stomach contents. Results of scat analyses are listed in parentheses. The major individual items in each category, together with their volumetric contributions, are shown above each bar chart.

points to known remains of moose killed by hunters in other cases.

The wing of a female goldeneye (*Bucephala* sp.), both wings and feet of a Varied Thrush (*Ixoreus naevius*), and pieces of fish skin all found in one stomach suggested that the bear involved had been cleaning up after a smaller predator. A fledgling White-crowned Sparrow (*Zonotrichia leucophrys*) and two species of microtines found in my analyses were probably captured by the bears involved.

Insects of the Order Hymenoptera constituted an important proportion of the animal food consumed. Adults, eggs, and pupae of ants (Formicidae) and wasps (Vespidae) occurred frequently, the former family being more important in the spring season and the latter in the early fall.

Other. Garbage, material discarded by human beings, was taken more often in the spring than it was in the fall. Bears which ate garbage usually ate large amounts. Debris refers to naturally occurring items that were obviously accidental or at least incidental. Pieces of rotten wood (which often occurred when ants were present), wasp nest material, and small stones were common debris items.

Discussion

Food habits. The importance of green vegetation in the spring diet of black bears in interior Alaska is consistent with findings in other areas, though the specific plants involved differ from area to area. Horsetail, the predominant spring food in interior Alaska, was also important in northwestern Montana according

to Tisch (1961), although grasses and umbellifers were more so. Chatelain (1950) found that "grass and grass-like plants" (including horsetails) composed the spring staples on Alaska's Kenai Peninsula. Except for grasses, other green plants in the interior Alaskan sample, such as wild rhubarb and lupine, were little used in other areas. Although roots and bulbs are popularly considered to be the favored spring bear foods, leafy material and young shoots appear to be the plant parts used most often in the interior of Alaska.

Animal food constitutes a relatively small portion of the black bear's total diet. In terms of frequency of occurrence, insects compose one of the most important animal foods as determined in this study and in the work of Tisch (1961), Chatelain (1950), Spencer (1955), Gilbert (1951) and others. A concentration of insects is apparently prerequisite to use of these organisms by bears as evidenced by the fact that colonial hymenopterans, especially ants, are the insects taken most consistently in all areas. Vespids, which were very abundant in 1964, were often eaten by bears during both years of this study. Entire nests were consumed in many cases, and obviously, the many hundreds of larvae packed into the combs of these formed an excellent source of concentrated animal protein.

Vertebrate animal food of black bears, except for fish in some areas, is largely carrion. Cottam, et al. (1939) and Spencer (1955) each record two minor occurrences of lagomorphs in their work, and though it was not known for sure, these probably were taken as carrion. The high incidence of hare carrion reported in this paper is apparently unique and no doubt reflects the fact that both hares and their predators were at or near the peak of their "cycle" during the years of the study. The cervid remains found in the interior Alaskan food habits analyses were almost certainly carrion.

Of fruits eaten by bears, *Vaccinium* appears to be one of the most important genera on the continent. Blueberries within the genus were by far the most important fall food in interior Alaska, were important on the Kenai Peninsula (Chatelain, 1950), were second only to acorns in early winter along the lower East Coast (Cottam et al., 1939), and ranked third behind apples and cherries in Maine (Spencer, 1955). Huckleberries within the genus were important to bears in northern Idaho (Rust, 1946) and were the most used berries in northwestern Montana (Tisch, 1961), still within the genus, lowbush cranberries were commonly eaten in the spring and late fall in interior Alaska. These were also much used in the Kenai Peninsula according to Chatelain (1950).

Even though *Vaccinium* is commonly used at lower latitudes, it seems to achieve its highest level of importance in northern regions. The many other fruits, including mast, which rival Vaccinium farther south (Tisch, 1961; Cottam et al., 1939; Bennett et al., 1943) are not available to Alaskan bears. Of the other fruits which are available in interior Alaska, some such as rose hips, highbush cranberries, and crowberries are important but are only occasionally so. Thus, the total picture in the interior during much of the fall period is one of consistent use of blueberries together with occasional use of a few other fruits. In comparison, as shown by Tisch (1961). Montana bears make consistent use of four or five fruits and occasional use of several others.

The opportunistic, omnivorous nature of the black bear has been stressed throughout the literature. This generally accurate characterization implies that simple food availability is one of the most important factors governing food habits and, indeed, the effects of availability have been obvious throughout this discussion. The use of green vegetation in the spring, of berries in the fall, and of animal material whenever possible are all functions of availability. But, within this broad pattern, other factors such as efficiency in meeting nutritional requirements and preference must be active for some available food items are used much more extensively than are others. In interior Alaska, the two plant genera, *Equisetum* and *Vaccinium,* were found to be such items. Evidence accumulated during this study plus

TABLE 3. — Foods consumed by black bears in interior Alaska, 1964-1965[1]

Food Item	23 Stomachs			16 Intestines			44 Scats		
	Freq. (Percent)	Percent[2] Trace	Mean[3] Percent Vol.	Freq. (Percent)	Percent Trace	Mean Percent Vol.	Freq. (Percent)	Percent Trace	Mean Percent Vol.
GREEN VEGETATION	100	17	71.0	88	0		100	6	51 - 75
	100	45	12.0	100	88		89	64	1 - 5
Equisetum spp.	92	9	61.8	63	40	83.7	94	0	51 - 75
	45	20	36.2	25	50	27.5	21	17	26 - 50
Gramineae	33	0	12.0	38	0	44.0	44	43	1 - 5
	27	33	1.6	0			39	64	6 - 25
Polygonum	17	50	2.4	13	0	10.0	0		
	0			0			0		
Lupinus arcticus	8	100	trace	0			0		
	36	50	12.0	37	100	trace	18	80	1 - 5
Pedicularis spp.	17	0	16.0	13	0	65.0	0		
	9	100	trace	0			0		
Galium boreale	17	0	10.2	33	0	15.0	0		
	0			0			0		
unident. green	8	0	38.0	38	33	23.0	6	0	26 - 50
	9	100	trace	0			0		
Ledum decumbens	42	100	trace	13	100	trace	31	100	trace
	82	100	trace	87	100	trace	39	100	trace
Betula glandulosa	8	100	trace	0			6	100	trace
	64	100	trace	50	100	trace	14	100	trace
Salix spp.	8	100	trace	25	100	trace	13	100	trace
	18	100	trace	13	100	trace	18	80	1 - 5
Picea spp.	50	100	trace	50	100	trace	56	100	trace
	27	100	trace	13	100	trace	39	100	trace
Populus tremuloides	8	100	trace	25	100	trace	0		
	0			0			14	75	1 - 5
Betula resinifera	0			0			13	100	trace
	9	100	trace	13	100	trace	11	100	trace
Compositae	0			13	0	15.0	0		
	0			0			0		
Carex spp.	0			0			6	100	trace
	0			0			7	50	1 - 5
Musci	8	100	trace	0			0		
	9	100	trace	0			7	50	1 - 5
FRUIT	58	14	12.0	88	43		75	0	6 - 25
	100	0	59.0	100	0		93	0	76 - 100
Vaccinium uliginosum	17	100	trace	38	100	trace	13	50	76 - 100
	100	9	49.9	100	13	78.0	79	0	51 - 75
Vaccinium vitis-idea	58	14	22.5	88	14	53.3	75	8	6 - 25
	64	86	10.4	50	75	23.0	39	36	51 - 75
Rosa acicularis	17	100	trace	13	100	trace	0		
	73	38	24.8	75	83	80.0	29	13	6 - 25
Empetrum nigrum	0			38	33	7.5	6	0	1 - 5
	36	25	8.0	75	50	33.3	25	50	6 - 25
Viburnum edule	8	100	trace	13	100	trace	0		
	18	0	4.3	25	50	15.0	18	0	6 - 25
Arctostaphylos uva-ursi	17	100	trace	13	0	8.0	0		
	9	100	trace	0			14	50	6 - 25
Arctostaphylos alpina	0			0			0		
	0			0			18	40	1 - 5
Ribes triste	0			13	100	trace	0		
	9	100	trace	13	100	trace	11	67	6 - 25
ANIMAL FOOD	67	13	6.0	63	100		69	9	1 - 5
	73	25	15.0	63	80		57	19	1 - 5
Lepus americanus	33	0	13.4	50	100	trace	38	0	6 - 25
	45	40	5.6	13	100	trace	36	20	6 - 25

TABLE 3. — (*Continued*)

Food Item	23 Stomachs			16 Intestines			44 Scats		
	Freq. (Per-cent)	Per-cent[2] Trace	Mean[5] Percent Vol.	Freq. (Per-cent)	Per-cent Trace	Mean Percent Vol.	Freq. (Per-cent)	Per-cent Trace	Mean Percent Vol.
Alces alces	8	0	2.5	0			0		
	18	50	43.7	0			14	50	6 - 25
Synaptomys borealis	8	0	1.7	0			0		
	0			0			0		
Zonotrichia leucophrys	0			0			0		
	9	0	1.6	0			0		
Bucephala sp.	8	0	2.1	0			0		
	0			0			0		
Ixoreus naevius	8	0	1.1	0			0		
	0			0			0		
Formicidae	33	50	11.6	13	100	trace	31	0	6 - 25
	27	67	1.4	0			11	33	6 - 25
Vespidae	8	100	trace	0			0		
	45	20	17.5	63	80	5.0	18	20	1 - 5
Cynipidae	0			0			0		
	9	0	3.6	0			0		
OTHER	50	0	11.0	50	50		13	100	trace
	82	11	14.0	13	0		32	22	1 - 5
Garbage	25	33	93.3	38	67	3.0	6	100	trace
	9	0	10.8	0			18	60	26 - 50
Debris	33	0	5.6	13	0	20.0	6	100	trace
	64	14	16.0	13	0	28.0	18	0	6 - 25

[1]The upper row of figures for each food item constitutes spring findings; the lower row shows fall data.
[2]Percent of all occurrences which were at trace level only (less than 1 percent by volume).
[3]The average percentage volume for those occurrences greater than trace.

recorded observations from past years suggest that interior Alaskan black bears are quite dependent upon blueberries. This hypothesis, as it may relate to the 1963 bear problems alluded to in the introduction, is discussed in detail in Hatler (1967).

Other Foods. Although my samples are reasonably complete for most habitat types, my having obtained only three sample units from lakeshore-marsh areas during the spring season has no doubt resulted in my missing food items, some of which may be important to bears at least temporarily. P. E. K. Shepherd (pers. comm.) has observed bears feeding on buckbean (*Menyanthes trifoliata*) along floating-mat lake edges in the Minto Flats, and he says that while they are so engaged, the animals often happen upon waterfowl nests (which they subsequently prey upon). The nests of scaup (*Aythya* sp.) are said to be particularly susceptible. Alaska game biologist Karl Schneider (pers. comm.) says that many duck nests were lost to bears in the Tetlin Lake area, east-central Alaska, in 1964. Rowan (1928) has recorded duck egg predation by bears previously.

Besides buckbean and waterfowl eggs, neither of which occurred in my findings, a number of other items including the shoots of other succulent marsh plants and the eggs and nestlings of a variety of other birds are theoretically available, and are likely taken at least occasionally by bears in these lowland areas. Moose meat also would probably have occurred in higher incidence if I had obtained a larger sample from lowland flats. R. A. Rausch (pers. comm.), Alaska game biologist, has indicated

that during spring moose census flights, biologists are frequently attracted to winter-killed moose by the presence of bears. Additionally, moose calves become available in the lowlands in late May and early June. The preceding statement does not imply serious predation. LeResche (1968) did not believe moose calf predation by black bears was significant on the Alaskan calving areas he studied, although he did find rather high calf mortality. A more extensive discussion of interior Alaskan black bears as predators is presented elsewhere (Hatler, 1967).

In early May, 1967, on a trip to the upper Steese Highway study area, I found two bear scats each consisting of roughly 25 per cent *Equisetum* and 75 per cent bearberries (*A. uva-ursi*). The stomach of a large male bear taken at this time contained, in addition to some *Equisetum,* an estimated two liters of these very dry and rather tasteless berries. It is not known what amount of nutrition was being obtained, but the fact that most of the berries in both scats and stomach were still intact suggests that it was not great. This incident is of interest in that bearberries had showed up only as trace or very small-volume occurrences in sample units obtained in 1964 and 1965. Further, spring sample units from this particular area during the study years had typically contained cranberries and on one occasion, crowberries, but never bearberries. The main factor leading to the change was the unusually hot, dry fall of 1966 which reduced both cranberry and crowberry production. The apparently more xerophilic bearberries were left in approximately "normal" abundance. This experience serves to emphasize the degree to which availability may dictate the food habits of individual bears, and suggests the error which could result should studies be conducted during "abnormal" years.

Appraisal of Food Habits Study Techniques

There is no indication in the literature that analysis of intestinal contents has been used in bear food habits work before. This is understandable, as the intestinal tract is inconvenient to transport and store and is quite messy to work with. In addition, digestion in the duodenal region is difficult to stop. Even after prompt injections of formalin, the identity of many items in the first 2 m of the intestine can be lost in just a few hours. The intestinal analyses did yield some food habits data. However, their greatest contribution was the insight they provided into the results of transforming a "meal" to a scat. Some of these results as they apply to certain foods follow:

Green plant material appears to be little changed in either form or volume as it passes through a bear's digestive system.

Of the fruits important to bears in interior Alaska, blueberries appear to be the least durable in the digestive tract. Looking in the distal portions of the intestines, the proportion of intact berries in berry masses is generally smaller for blueberries than it will be for other species. Hence, blueberries probably show the greatest relative loss of volume in their passage through a bear. Many highbush cranberries and rose hips will also be collapsed or broken in transit, but since resistant material constitutes a fairly large proportion of the fruit of each of these species (large seed and tough skin in the former and many seeds in the latter), their integrity of volume is maintained fairly well. Lowbush cranberries and crowberries are quite durable throughout most of the berry season. However, after the first few frosts (about mid-September) both of these species become more like blueberries both in consistency and in reaction to digestion.

Of the main food categories, animal material appears to undergo the most drastic changes in a bear's digestive tract. Identity is seldom lost, as resistant materials (hair, claws, chitin, etc.) will usually be ingested with the meat of an animal meal. But, there are indications that quantitative changes may be fairly great. Of the 16 bears for which I obtained both stomach and intestines, 10 had one or more above-trace occurrences of animal material in their stomachs, yet only 1 contained animal material at greater than trace level in its intestines. At least part of this difference was attributable to the effects of digestion.

TABLE 4. — Black bear food items occurring three times or less, and only at the trace level.

Food item	Number of occurrences				
	Stomachs		Scats		Total
	Spring	Fall	Spring	Fall	
PLANT FOOD					
Ranunculaceae	1				1
Rosaceae (greens)	2		1		3
lichens	1			1	2
ANIMAL FOOD					
Lemmus trimucronatus				1	1
unident. bird			1		1
Osteichthyes	1				1
Culicidae	1	1	1		3
Bombidae (?)			1	1	2
Coleoptera	1				1
Lepidoptera				1	1

Note: There were no occurrences of this kind in the intestinal samples.

When insects occurred in stomachs, larvae and eggs (particularly of wasps) constituted a large proportion of the total insect volume. In intestines and scats, except for occasional collapsed skins, larvae and eggs were rarely evident although adults (probably preserved because of their greater chitin make-up) occurred frequently. Similarly, pieces of meat occurred with some of the vertebrate remains found in stomachs, but only hair, claws, and occasional bits of hide, bone and cartilage were found in intestines and scats.

Debris material was generally not affected by digestive processes. Wasp nest material proved to be an exception. After it had become moistened it appeared to lose considerable volume (probably through compression, although some of its components may have been soluble in the digestive fluids). Garbage materials usually remained identifiable as such throughout the digestive tract and, owing to a usually high incidence of undigestible items, rarely appeared to suffer volume changes.

In an actual comparison of my data, we see that the results of scat analyses (for the major food categories) are quite comparable to the results of my stomach analyses (Figures 2 and 3). Further, as an examination of Table 3 will show, there is agreement in order of magnitude between stomach data and scat data for many individual items. This is particularly true of some of the more important foods.

It should be evident that this comparison, on the basis of data differences (or similarities), is subject to interpretive error. Differences may be real due to actual differences in food habits between bears contributing to the stomach samples and those contributing to the scat samples, or they may be apparent due to errors in one technique or the other. In the same manner, similarities may be real or they may be coincidental due to error. Field observations both during and after the study support the laboratory data, and I therefore assume that most of the similarities are real, not just coincidental. It may sound as though, in making this assumption, I am saying that one technique is no better than the other. In reality, as I shall soon point out, the answer to this lies in the application of a particular study.

Since few items lose their identity during digestion, it is my conviction that frequency of occurrence data from scat analysis is very nearly as good as that from stomach analysis. We might expect, from what was mentioned earlier, that animal material would be better represented in the stomachs. Indeed, Table 3 meets this expectation in showing that a greater variety of animals was found in stomachs than in scats, although the rare, one-time occurrence items constitute the difference. Among the animals that appeared to be consistently eaten, frequency data for stomachs and scats are similar. As Table 4 shows, this does not imply that minor items do not show up in scat data.

With respect to volume, we should expect an under-representation of animal material in scats. This does not show up in my data, perhaps partly because the method of estimating a volume category in scat analysis may serve to automatically cancel the diminishing effects of

digestion. Recall that during the intestine studies, blueberries were also found to diminish in volume during passage through the digestive tract. Despite this fact, these berries are usually taken in large quantities and there is little danger of their being greatly under-represented.

In conclusion, I feel that a good collection of scats can justifiably serve as a base for nearly any bear food habits study. If a study is oriented toward determination of basic food habits patterns, scats alone may be adequate. If emphasis is to be placed upon the animal food of the bears concerned, a series of stomachs will also be needed both to insure that reliable quantitative data are obtained and to insure that the data are properly interpreted. For example, if I had used only scats in my study, I could have said nothing about the incidence of *Lepus* in my findings. However, noting the nature of *Lepus* occurrences in the stomachs, I was able to state quite confidently that most and probably all represented carrion.

An obvious advantage of scats over stomachs is the fact that a single bear can yield much more information, over a period of time, by contributing the former rather than the latter. However, one should be careful about the degree to which he relies upon the individual tastes and/or opportunities of a single animal for the sake of "building up sample size." This is not to belittle sample size, the importance of which is well known (see Korschgen, 1969). But the assumption we make in collecting sample units such as scats, i.e., that each unit picked up is independent of the last one, is certainly not always valid and, to my knowledge, the bias which can result has not even been discussed previously. Stomach analysis avoids the above problem but, of course, is not practical for small populations or rare species. A final consideration in the comparison of scat analysis and stomach analysis is the time and effort involved in each. It was my experience that scats are far easier to obtain, transport, and store than are stomachs. Further, it took an average of about one half hour to analyze a scat whereas 6 to 8 hours were required for intensive analysis of each stomach.

Acknowledgements

This investigation was financed by funds from Federal Aid to Wildlife Restoration, Alaska projects W-6-R-6 and W-15-R-1 through the Alaska Cooperative Wildlife Research Unit. I would like to express my indebtedness to a number of people whose assistance proved valuable, especially Dr. Frederick C. Dean who provided advice and leadership throughout the study, and who carefully reviewed the manuscript. Dr. David R. Klein contributed many helpful suggestions, and he and Dr. Russell D. Guthrie provided useful criticisms of an earlier version of the manuscript. Botanists, Dr. Vernon L. Harms and Dr. Leslie A. Viereck, aided in identification of plant materials. Alaska Department of Fish and Game personnel, especially Messrs. Robert A. Rausch and Richard H. Bishop, were generously cooperative and helpful.

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Pollen Characteristics of Manitoba Cattails

JANET R. DUGLE AND THEODORE P. COPPS
Atomic Energy of Canada Limited, Whiteshell Nuclear Research Establishment, Pinawa, Manitoba

Abstract. Pollen morphology of the three Manitoba cattails, *Typha latifolia* L., *T. angustifolia* L. and *T.* x *glauca Godron (T. latifolia* x *T. angustifolia)* are presented in detail through use of scanning electron and light microscopes. *T.* x *glauca* is reported from the province for the first time, and *T. angustifolia* is now confirmed as established in Manitoba.

Introduction

While preparing a checklist of the flora of the Whiteshell area in southern Manitoba (Dugle 1969, Dugle and El-Lakany 1971) some cattails (genus *Typha* — Typhaceae) were found which did not fit the description for *Typha latifolia* L., the only species previously listed for the Canadian prairies (Budd and Best 1964). Scoggan (1957) listed the same cattail for Manitoba, and mentioned that specimens of *T. latifolia* forma *ambigua* (Sonder) Kronf. were collected near Boissevain and Brandon. This form, however, had typical *T. latifolia* pollen grains. Hartley's checklist (Hartley 1968) also listed only *T. latifolia* for the Thunder Bay region in Ontario. Both northern species, *T. angustifolia* L. and *T. latifolia* were listed by Lakela (1965) for Minnesota, by Dugle (1960) for northern South Dakota, and by Stevens (1963) for North Dakota. Stevens commented that *T. angustifolia* was a recent introduction in North Dakota, being first reported in 1942. Natural and experimental hybridization in the North American species of *Typha* were extensively studied by Smith (1967). His distribution map showed *T. angustifolia* extending into the southeastern corner of Manitoba, although voucher specimens were not cited for this range extension. A wide range of Manitoba cattail material has therefore been examined to determine the species occurring in the province, and their distribution. Studies of pollen grain morphology were undertaken, in addition to an evaluation of traditionally used characters, and the results proved valuable in distinguishing the taxa encountered.

Materials and Methods

Gross morphology was studied in the herbarium specimens listed in the Appendix, and these are deposited in the herbarium of the Whiteshell Nuclear Research Establishment, Pinawa, Manitoba (WNRE) and the University of Manitoba herbarium (WIN).

Identification was based largely on the characters suggested by Smith (1967). Several of these were macroscopic, such as leaf width, leaf sheath auricle presence or absence, interval between male and female spikes, and width of mature female spike. In addition, microscopic features such as bracteoles and gynophore hairs were examined (Smith 1967).

Internal structure of pollen grains from the specimens were studied by light microscopy using a Zeiss Photomicroscope II. The scanning electron microscope (Cambridge Instrument Co., Stereoscan Mark IIA) was used to investigate the surface topography and structure of pollen grains. The material for scanning electron microscopy was mounted on two sided adhesive tape or with natural adhesion on fragments of glass cover-slips attached to the aluminum mounting stub with silver dag[1]. The pollen grains were sprinkled onto the surface by tapping or brushing with a fine artist's brush. The mounted specimens were allowed to dry slowly for a period of 48 hours under a glass petri dish, after which they were placed in a desiccator over silica gel to complete the drying. While rotating the specimen, a film of gold, silver or gold-palladium was evaporated on the surface of the grains to a thickness of ~ 250 A.

[1] "Dag" Dispersion #416, Kent-Cambridge Ltd., Willowdale, Ontario.

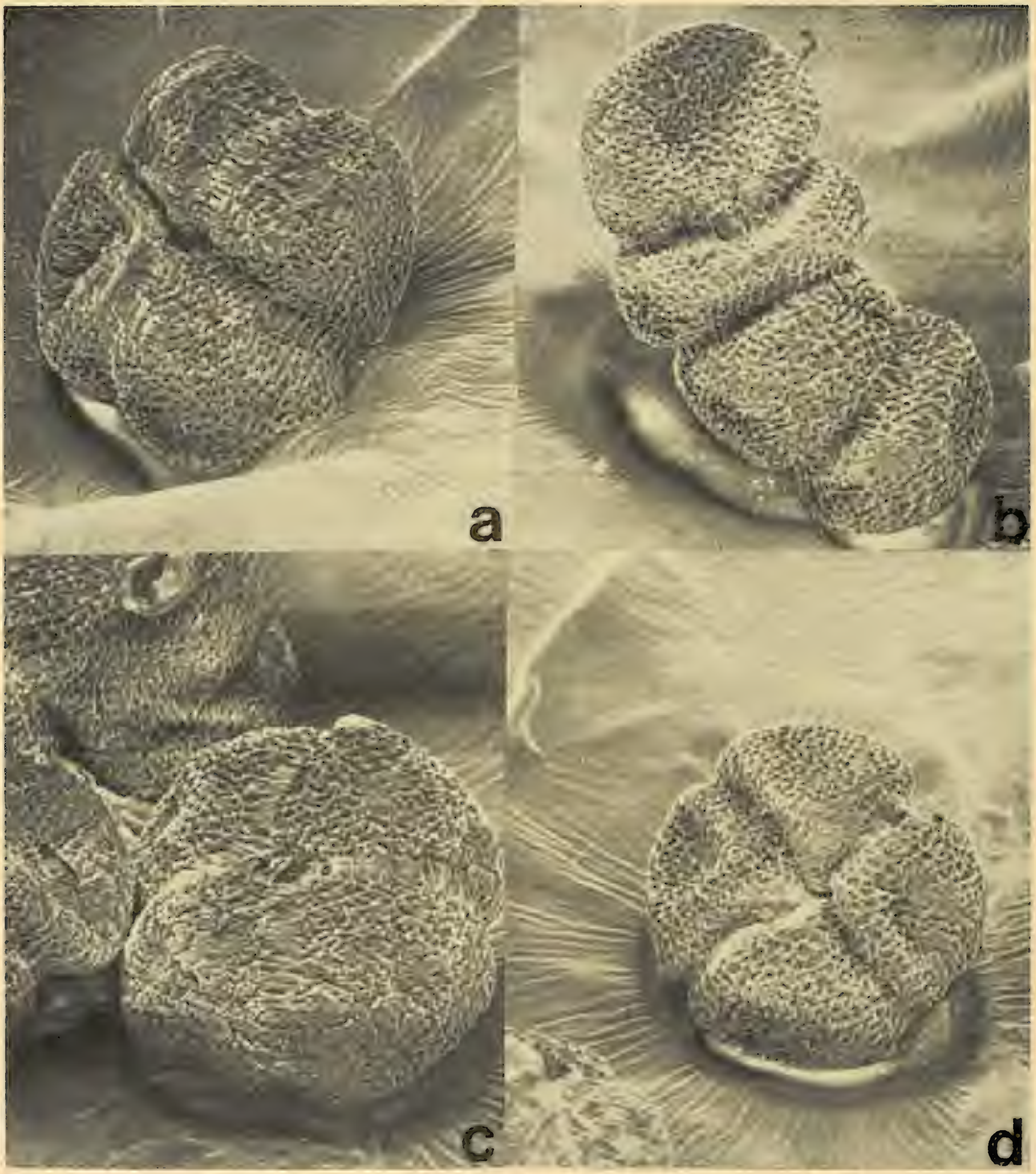

FIGURE 1. Pollen of *Typha latifolia* (J. Dugle 5564) x 1400

Results and Discussion

The presence in Manitoba of *Typha angustifolia* is confirmed, and *T.* x *glauca,* its hybrid with *T. latifolia* is reported for the first time from the province. From sight records and the specimen distribution the taxa were found to be quite common, and the characteristic clones can be recognized from a distance. McDonald (1951) and Yeo (1964) have pointed out that a single seed can result in a large clone of mature plants by vegetative reproduction. Therefore, even a semi-fertile or sterile F_1 can spread over a wide area. Apparently F_2 plants are quite rare, but backcrosses are not uncommon (Smith 1967) (Appendix). Experimental hybridizations have been very successful (Smith 1967). Hybridization can be expected in nature, as in the Pinawa area flowering time is overlapping although *T. latifolia* reaches a peak earlier than *T. angustifolia.* Flowering time varies slightly from clone to clone in all three taxa.

Although modern *Typha* pollen (Figures 1-6) is entirely anemophilous, Wodehouse (1935) has suggested this may be a derived condition from an entomophilous ancestor because ridges and spines on the exine are characteristic of insect pollinated species. There is a trace of buttressing at the base of the ridges (Figures 1, 3, and 6) suggesting an ancestor having a heavily sculptured exine. The single germinal pore is irregular, and the membrane does not expand when the grain is moist. The sculptured exine is not rigid enough to require an expansion furrow. The thin wall of the grains causes them to collapse during desiccation (Figures 1, 3, and 6), but there is no relation to the pore when they collapse as is common in plants which have a thicker exine. On the single grains, a pattern of parallel ridges may be seen which corresponds to former cell contact areas within the pollen mother cell (Figure 3, especially 3a).

Pollen of *T. latifolia* is shown in Figures 1 and 2. The grains are always in a tetrad which modifies their shape. The orientation of the four grains varies, although they are commonly flat, and in an unstable (square) configuration (Figures 1a and 1c) rather than a stable, rhomboidal one (Figures 1d and 2b). An additional uncommon orientation is shown in Figures 1b and 2c. The low surface ridges are finely reticulate with a trace of buttressing at the base. The reticulum is continuous across the cell boundaries in the tetrad and the ridges often appear "stretched" (Figure 1). The pollen is highly stainable (Figure 2), and is less than 2% abortive, suggesting a high fertility. Pollen brushed from the pistillate spike had produced pollen tubes from nearly every cell. The tetrad averages 40 μ in diameter (range 37 – 42 μ). The individual grains average 21.4 μ in diameter (range 18.4 – 25.5 μ), in very good agreement with measurements by Wodehouse (1935) (18.2 – 22.8 μ).

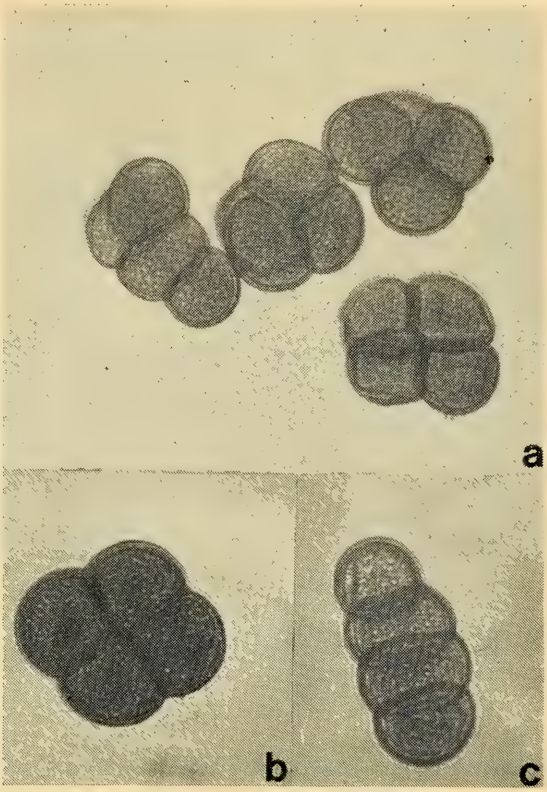

FIGURE 2. Pollen of *T. latifolia* a. (J. Dugle 5508) x 750 b. and c. (J. Dugle 5564) x 750

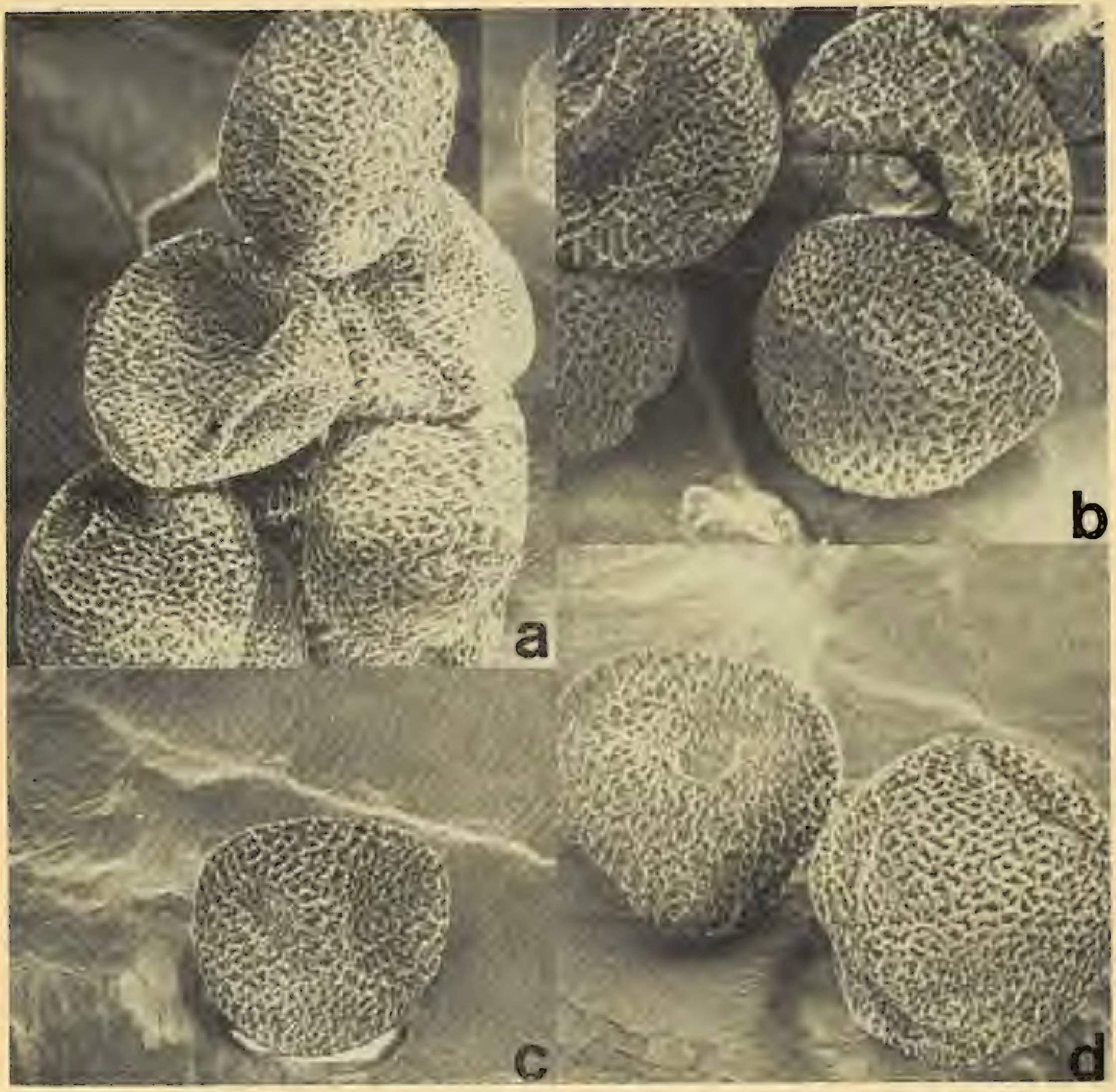

FIGURE 3. Pollen of *T. angustifolia* (J. Dugle 5562) x 1400

Pollen of *T. angustifolia* (Figures 3 and 4) is not released in a tetrad, and so is easily distinguished from *T. latifolia*. The chromosome number of the two species is the same (Smith 1967) but the individual grains appear to be very slightly larger in *T. angustifolia*. They average 24 μ in diameter (range 21.0 – 26.0 μ), which agrees with measurements reported by Wodehouse (1935) (19.4 – 26.2 μ). The pollen is less than 4% abortive. The germinal pore can be seen in Figures 3 and 4. Open lacunae exist on the undifferentiated margin of the pore. The surface reticulum is very similar to that of *T. latifolia,* but the ridges appear to be slightly higher and sharper.

The grains of *T.* x *glauca* (Figures 5 and 6) are very similar to those of *T. angustifolia* in surface characters. The ridges are higher and sharper than those in *T. latifolia.* Although most pollen grains are single, occasionally they are attached in twos, threes, or fours, and abortive grains are common (Figure 6). The pollen of specimen J. Dugle 5563 (Figures 5 and 6) is morphologically 65% abortive and the grains average 21.5 μ in diameter (range 17.5 – 25.5 μ). Buttressing at the base of the ridges can be seen in Figure 5d, as can granula. Pore structure is visible in Figure 5c.

Tsukada (1964) described pollen of *Typha* (unidentified as to species) in some detail from light microscope studies. He reported that tetrads were 42 – 45 μ, comparable to *T. latifolia* tetrads of 37 – 42 μ. His measurements for single grains were 27 – 35 μ in diameter, which is larger than those of either *T. angustifolia* or *T.* x *glauca.*

It is apparent that some species in the genus *Typha,* and especially *T. angustifolia,* are actively migrating northward and westward. This should result in considerable gene flow through hybridization and introgression, thus increasing the ecological amplitude of the parental species. It is interesting to speculate, as Wodehouse (1935) has done, that the family is advanced because of the entomophilous-type pollen. Unfortunately close relatives do not exist for comparative studies.

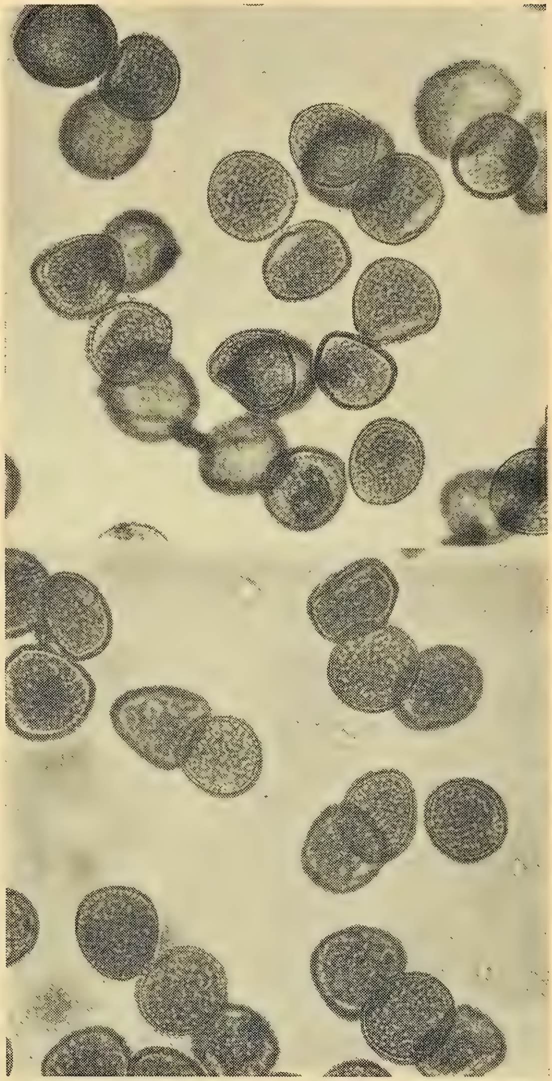

FIGURE 4. Pollen of *T. angustifolia* (J. Dugle 5562) x 750

Acknowledgements

We wish to thank Dr. Royce Longton and Dr. John Stewart, University of Manitoba, for the loan of *Typha* material and assistance in preparation of the manuscript.

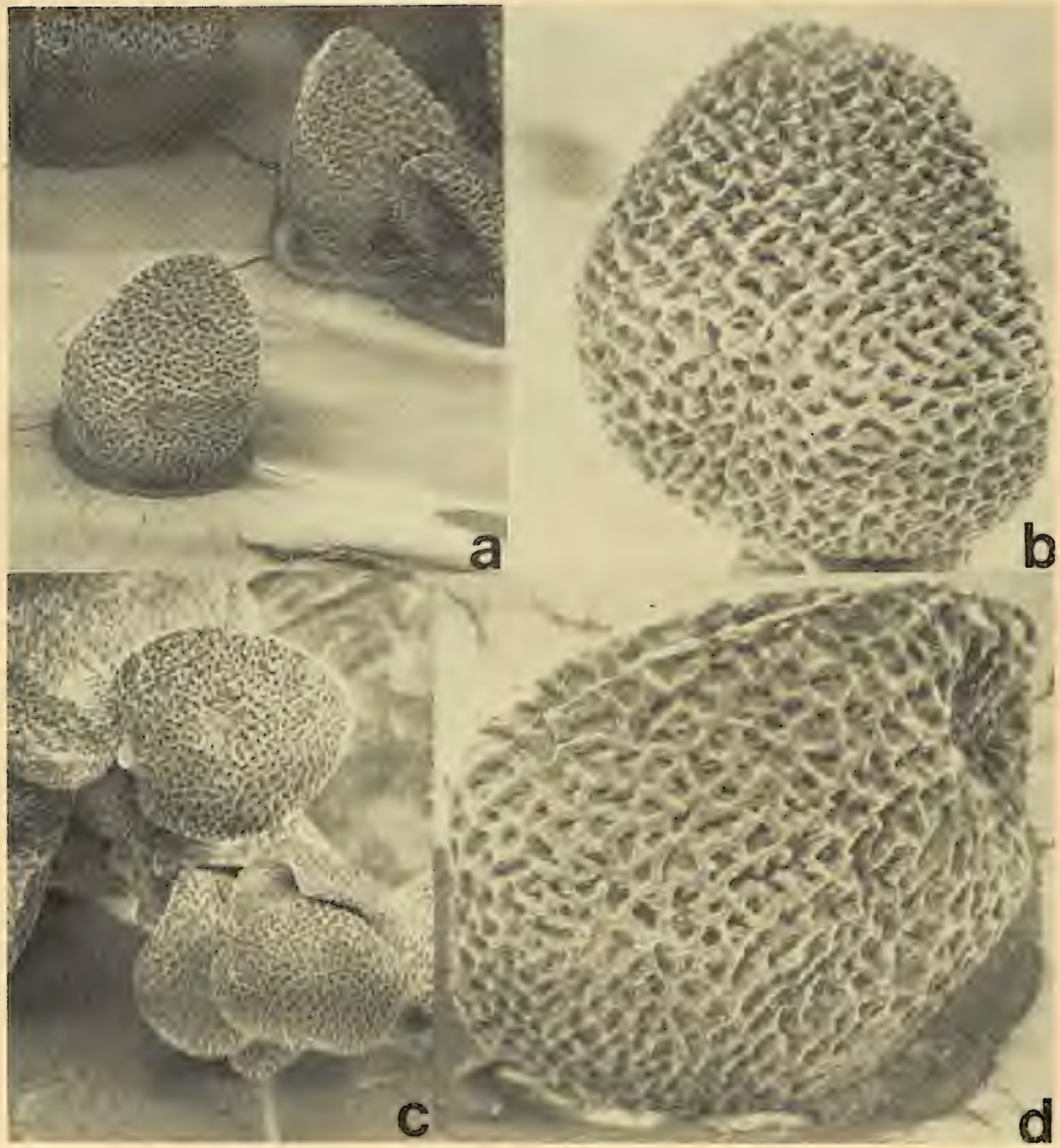

FIGURE 5. Pollen of *T.* x *glauca* (J. Dugle 5563) a. and c. x 1400 b. and d. x 3500

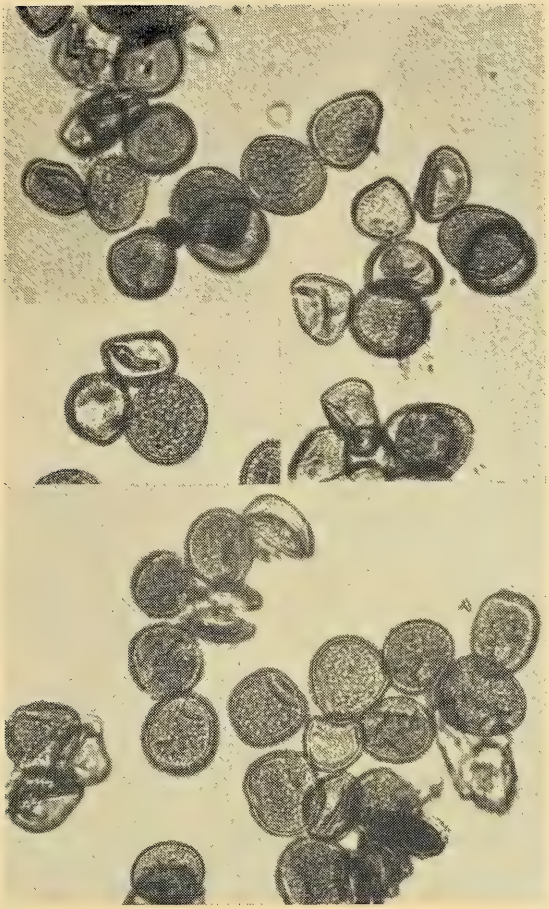

FIGURE 6. Pollen of *T.* x *glauca* (J. Dugle 5563) x 750

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APPENDIX

Typha angustifolia L. MANITOBA: Agassiz Provincial Forest, J. Dugle 5562; WNRE controlled area, J. Dugle 5823; Vita, B. Boivin and J. M. Perron 12945 (WIN); Sec. 18-26-22 J. L. Parker 1403 (WIN). SOUTH DAKOTA: Codington Co., J. Dugle 230 (USD); Union Co., T. Sheehan 144. MINNESOTA: Clay Co., L. Kukla 332; Beltrami Co., B. Turner T-191.

T. x *glauca* Godron MANITOBA: Agassiz Provincial Forest, J. Dugle 5563; WNRE controlled area, J. Dugle 5820, 5821, 5822; North West Angle Forest Reserve, J. Dugle and D. Dugle 4514; WNRE controlled area, W. Chunys 715; Vita, B. Boivin and J. M. Perron 12946 (WIN). MINNESOTA: Duluth-Superior harbor, P. Monson 4276.

T. latifolia L. (with gene flow from *T. angustifolia*) MANITOBA: WNRE controlled area, J. Dugle 5818; Birtle, M. G. Dudley July 1930 (WIN).

T. latifolia L. MANITOBA: North West Angle Forest Reserve, J. Dugle and D. Dugle 4515; Near U.S. border, SE Manitoba, J. Dugle and D. Dugle 4433; Pinawa townsite, J. Dugle 5508; Agassiz Provincial Forest, J. Dugle 5564; WNRE controlled area, J.

Dugle 5819, W. Chunys 1090, B. Turner 5985; Vita, B. Boivin and J. M. Perron 12947 (WIN); Rufford, A. and D. Löve 5895 (WIN); Third Cranberry Lake N.J. Freedman July 12, 1954 (WIN); Oakland, A. Löve 5116 (WIN); Brokenhead, T. Mosquin July 1, 1952 (WIN); Schist Lake, N.J. Freedman June 1952 (WIN); Wekusko Lake, H. J. Scoggan 6627 (WIN); Paskwachi Bay, W. K. W. Baldwin 2408 (WIN); Langruth, J. Carrick Aug. 1949 (WIN). ONTARIO: Kenora, A. H. R. Buller July 1918 (WIN). NORTH DAKOTA: Eddy Co., G. Seiler 1390. SOUTH DAKOTA: Codington Co., J. Dugle 244 (USD); Union Co., T. Sheehan 113. MINNESOTA: Mahomen Co., B. Turner T-60. *T. latifolia* forma *ambigua* (Sonder) Kronf. MANITOBA: Rufford, A. and D. Löve 5694 (WIN).

Heliotropism in some Arctic Flowers[1]

Peter G. Kevan[2]
Department of Entomology, University of Alberta, Edmonton, Alberta, Canada.

Abstract. Heliotropism is described for the flowers of four species of arctic plants. Only one, *Papaver radicatum* is heliotropic throughout the 24 hours of sun. The others, *Dryas integrifolia, Matricaria ambigua,* and *Senecio congestus* are heliotropic for several hours centered about solar noon. Heliotropism is abolished in cloudy weather. The significance of heliotropism is discussed in relation to intra-floral temperatures and reproduction.

Introduction

Heliotropism is defined here as the diel bending response, or turning, of plants directly to and with the sun. Thus heliotropism is a form of positive phototropism. Loeb (1890) used the term heliotropism to describe what is now known as phototaxis (Fraenkel and Gunn 1961) and until recently botanists have used the term interchangeably with, and to mean phototropism. Taxes are exhibited through locomotion, while tropisms are exhibited through curvatures of sedentary plants.

Although blooms such as *Helianthus* and others have long been known to turn to the sun throughout the day (Hooker 1881, Wiesner 1879, 1882) I can find no modern comprehensive account of this phenomenon except for two small works (Polikarnov 1954, Morozov 1963) demonstrating heliotropism in sunflowers under field conditions. Review articles such as by Schrank (1950), Brauner (1954), Reinert (1959), Briggs (1963, 1964) and others discuss the general mechanisms of phototropism and the physiology of auxins, but do not mention heliotropism *per se.* Schrank (1950) and Leopold (1964) briefly mention the responses of leaves to the sun.

Methods

Most of the following work was carried out at Hazen Camp (81° 49' N., 71° 18' W.) on northern Ellesmere Island, N.W.T. At various times during several days of sunny weather in 1967 and 1968 about 1,300 flowers of *Dryas integrifolia* M. Vahl (Rosaceae) and 137 flowers of *Papaver radicatum* Rottb. (Papaveraceae) were counted. The angle their radial axes made with respect to the horizontal component of the direction of insolation was noted according to the 45° sectors centered about the angles given as shown in Figure 1. The vertical component, i.e. the angle of solar altitude, is comparatively low and steady in the arctic, so the angles flowers made with respect to it were not measured.

While on the Tuktoyaktuk Peninsula, District of Mackenzie, N.W.T., in 1970 I noted

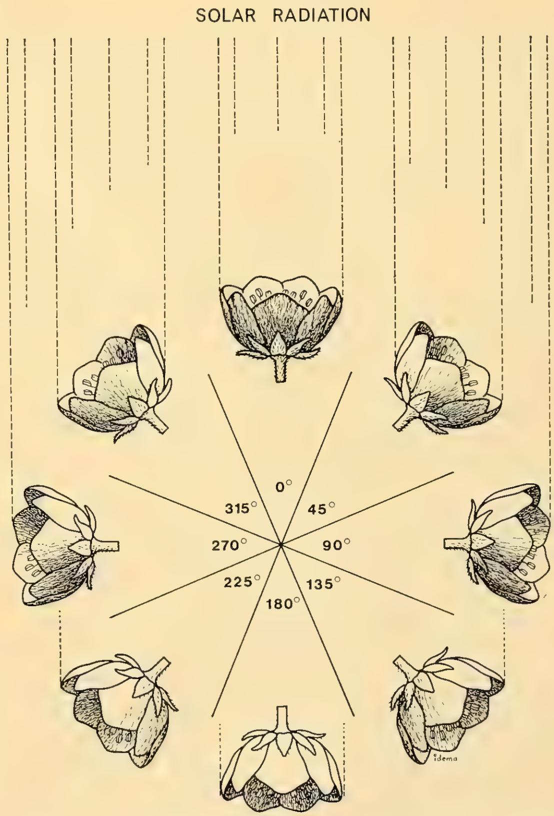

Figure 1. Orientation of flowers according to the 45° sectors of the direction of solar radiation used to determine heliotropic period (see text).

[1]Contribution No. 862, Plant Research Institute.
[2]Present Address: Plant Research Institute, Central Experimental Farm, Ottawa, Canada.

TABLE 1. — Dryas integrifolia, per cent in each sector with respect to the horizontal component of the angle of solar incidence (0° facing directly into the sun.)

Time	Date	% at each angle								Number of Flowers
		Angles								
		0	45	90	135	180	225	270	315	
0001	2.VII.1968	12	3	3	8	21	22	24	13	174
0200		10	3	5	12	26	12	21	13	154
0400		14	6	18	12	21	12	10	7	174
0700	5.VII.1967	73	5	11	1	2	2	6	1	274
0800	26.VI.1967	57	6	25	3	5	0	1	1	186
1100	27.VI.1967	92	2	0	0	0	0	4	2	50
1400		62	3	5	0	0	0	6	20	81
1700	8.VII.1968	20	5	4	4	5	10	20	31	166
2200	25.VI.1967	11	0	4	0	7	11	36	32	28
2300		5	0	0	10	15	15	45	10	20
										1307

that the flowering heads of *Senecio congestus* (R. Br.) DC, and *Matricaria ambigua* (Ledeb.) Kryl. (Compositae) appeared to be heliotropic. I scored a total of 857 blooms of *M. ambigua* at Tuktoyaktuk on July 9 and 10 in the same way as for *D. integrifolia*.

Results and Discussion

Table 1 and Figure 2 show that the heliotropic period for *D. integrifolia* starts at about 04:00 solar time and ends at about 17:00, a span of 13 hours, during 9 of which more than 50% of the flowers are pointing directly at the sun, and during 7, more than 70% are so directed. At about 13:00 heliotropy diminishes as some flowers lag behind and are counted in the "315° to the sun" category. This group apparently stay behind in that position and so 3 hours later are counted in the 270° category. The lag in these two curves is shown in Figure 2. After this time, more lagging can be seen, particularly at 225° and 180°, but these later orientations are obscured by the lagging of the remaining flowers and by their increasing disarray. Eventually, just as the flowers are about to resume heliotropism, they show no particular orientation.

Hocking and Sharplin (1965) state that *D. integrifolia* at Hazen Camp is heliotropic throughout the day, but my results disagree. *Papaver radicatum,* however, does remain heliotropic throughout the 24 hours of sun. During 13 different times throughout the 24 hours all the flowers of this plant were found directly facing the sun (see Figure 2). At Hazen Camp other blooms which may be somewhat heliotropic are *Potentilla nivea L.* ssp. *Chamissonis* (Hult.) Hiit. (Rosaceae) and *Taraxacum arctogenum* Dahlst. (Compositae). *Arnica alpina* (L.) Olin ssp. *angustifolia* (M. Vahl) Maguire (Compositae) is not.

The same effect as found in *D. integrifolia* is evident for *M. ambigua.* Between 18:00 and 20:00 hours solar time heliotropism ceases and blooms lag, appearing at 315° to the sun. As the light wanes and temperature drops many blooms become oriented horizontally, open to the sky. (*D. integrifolia* flowers do not become noticeably oriented to the sky when they are not showing heliotropism.) Between 04:00 and 08:00 heliotropism resumes as the blooms re-orientate to the sun. A cycle showing the heliotropic and non-heliotropic periods for *M. ambigua* is given in Figure 3.

All the blooms studied appear heliotropic during relatively clear and calm weather. During cloudy conditions no particular orienta-

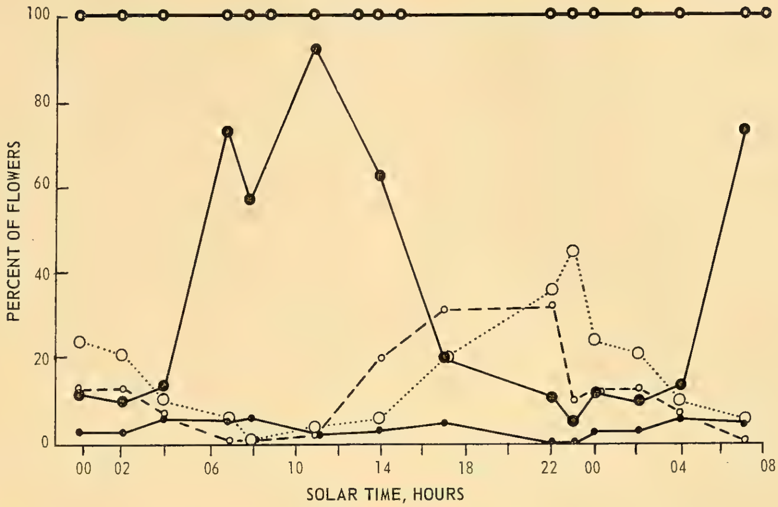

FIGURE 2. Per cent of flowers of *Dryas integrifolia* and *Papaver radicatum* showing various orientations to the sun throughout a day (composite of counts of several days observations). For clarity only four of the eight categories scored in *D. integrifolia* are shown. Heavy open circles and solid line, *P. radicatum*. Large solid circles and solid line, *D. integrifolia* facing directly to sun (0°). Small solid circles and solid line, *D. integrifolia* at 45° to sun. Small open circles and broken line, *D. integrifolia* at 315° to sun. Large open circles and dotted lines, *D. integrifolia* at 270° to sun.

tions to the sun are noticeable, and in wind the blooms are blown about.

I (Kevan 1970) made a detailed study of the temperature in flowers in the high arctic and related it to pollination biology. I found the mean temperatures in heliotropic flowers of *Dryas integrifolia* were about 3°C above the mean ambient air temperature (9°C) while those pointing away from the sun only about 1°C above ambient. On other occasions I found heliotropic flowers had mean temperature elevations above ambient of about 6°C and 7°C. Similar results were obtained for *Papaver radicatum*. Results on intral-floral temperatures of the Composites *Taraxacum* and *Erigeron* (Kevan 1970) suggest that *M. ambigua* and *S. congestus* also develop temperature excesses in direct sunlight.

The signifance of heliotropism to plants can be understood in the arctic environment with its low heat budget. The rates of metabolism of heliotropic flowers and inflorescences must be increased by solar warming for prolonged periods relative to non-heliotropic ones. Probably pollen tube growth and ovule development are hastened and increase the chance of successful seed-set. Also the ameliorated thermal regime in flowers may act as a mechanism for holding and attracting pollinators (Hocking and Sharplin 1965, Kevan 1970).

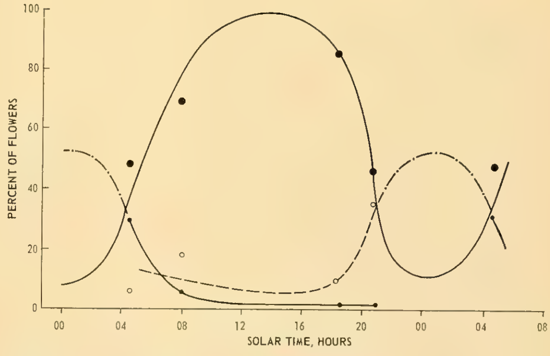

FIGURE 3. Percent of inflorescences of *Matricaria ambigua* showing various orientations to the sun throughout a day (composite of observations of several days and counts from 9 and 10 July, 1970, Tuktoyaktuk, N.W.T.). For clarity only three of the nine categories scored are shown. Large solid circles, facing directly into the sun. Small open circles, at 315° to sun. Small solid circles, facing the zenith.

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The Vegetation of Northern Keewatin

JAMES A. LARSEN

Center for Climatic Research, University of Wisconsin, Madison

Abstract. The vegetation of three areas in Northern Keewatin, N.W.T., Canada (Pelly Lake, Snow Bunting Lake, and Curtis Lake and Repulse Bay) is described particularly in relationship to the prevailing terrain and topographic conditions. Frequency tabulations are presented of species encountered during sampling of communities occupying relatively large proportions of the land surface in each area. The composition and characteristics of the plant communities found on the various topographic locations appear to be determined primarily by raw physical forces and secondarily, if at all, by the vegetational history of an area or competitive and successional relationships. Observations of frost action in the substrate indicate that this is the major cause of vegetational disturbance in the areas and that the concepts of succession and climax can be applied only with reservations since species initially comprising a community appear to be the same as those re-colonizing areas disturbed by frost activity.

Very little botanical exploration has been carried on in Northern Keewatin and the relatively brief descriptive report presented here is the first quantitative survey of plant communities undertaken in the region. It depicts a portion of a study by the author of relationships between vegetation and climate over the northern boreal forest and the tundra in the region extending west from Hudson Bay to the Cordillera. It is hoped the plant community information may be of some interest to others who may be inspired to work in these or other northern tundra areas. The three major study areas of concern here are the Pelly Lake area, the Snow Bunting Lake area, and the Curtis Lake — Repulse Bay area (see Fig. 1). These are treated individually and tables presenting tabulated community data and a number of photographs illustrating topographic and vegetational conditions are included.

The method for obtaining the data on the plant communities is similar to that employed by the author elsewhere (see Larsen 1965) and consisted essentially of tabulating frequency of occurrence of each species in quadrats of one square meter in size and shape arrayed 20 paces apart along a transect which followed a compass line through the community. The communities were selected visually and were located principally either in rock fields or low meadows unless otherwise indicated in the discussions. The definitions of these community types are given in somewhat greater detail in the above reference. It is perhaps of some interest that no communities that might be referred to as tussock muskeg are present in any of the study areas visited (see Tables 1-18).

PELLY LAKE SITE (101°03'W; 66°03'N)

General

Studies in the vicinity of the north arm of Pelly Lake were conducted during the period June 19 to July 17 (1966) with the base camp for the party located approximately four miles east of the north end of the north arm at an abandoned airstrip, the latter constructed for defense purposes and employed most recently as a base for aircraft flying the aerial photographic reconnaissance of northern Canada and geological surveys (Craig 1964).

The area has been described as underlain by gneissic granitic rocks, including some schist. The base camp was located at the southwestern edge of a zone of pitted outwash many square miles in extent (Craig 1964; National Topographis Series, Ogden Bay, N.W. 66/104, Sheets 66 N.W. and 66 N.E.) which was apparently deposited during a halt in the retreat of the ice front (Fig. 2). Craig points out additionally that some sparse evidence exists for the presence of the shoreline of either a glacial lake or an arm of the sea which extended into the valley of the Back River. At Beechey Lake a small delta with wave-cut scarp indicates the presence formerly of standing water which probably was of limited extent and which apparently occupied the valley for only a short time.

The southern edge of the outwash plain, near the airstrip and base camp, is marked by

FIGURE 1. Map showing the location of the study areas described in the text.

an abrupt termination of the sand and gravel outwash deposit, with barren sand slopes descending 50 to 100 feet or more to the surface of coarse boulder and gravel drift possessing the familiar surface features indicating extensive former glaciation.

A discussion of past climatic relationships of vegetation in the area is provided in the recent discussion by Nichols (1970), a member of our field party (see Acknowledgements). Pollen diagrams constructed from the result of pollen analysis of peat monoliths recovered from organic deposits show that the climatic history of the region, as so determined, correlates well with the history of other adjacent northern regions, particularly the Ennadai Lake area, as determined by Nichols earlier (see references in Nichols 1970).

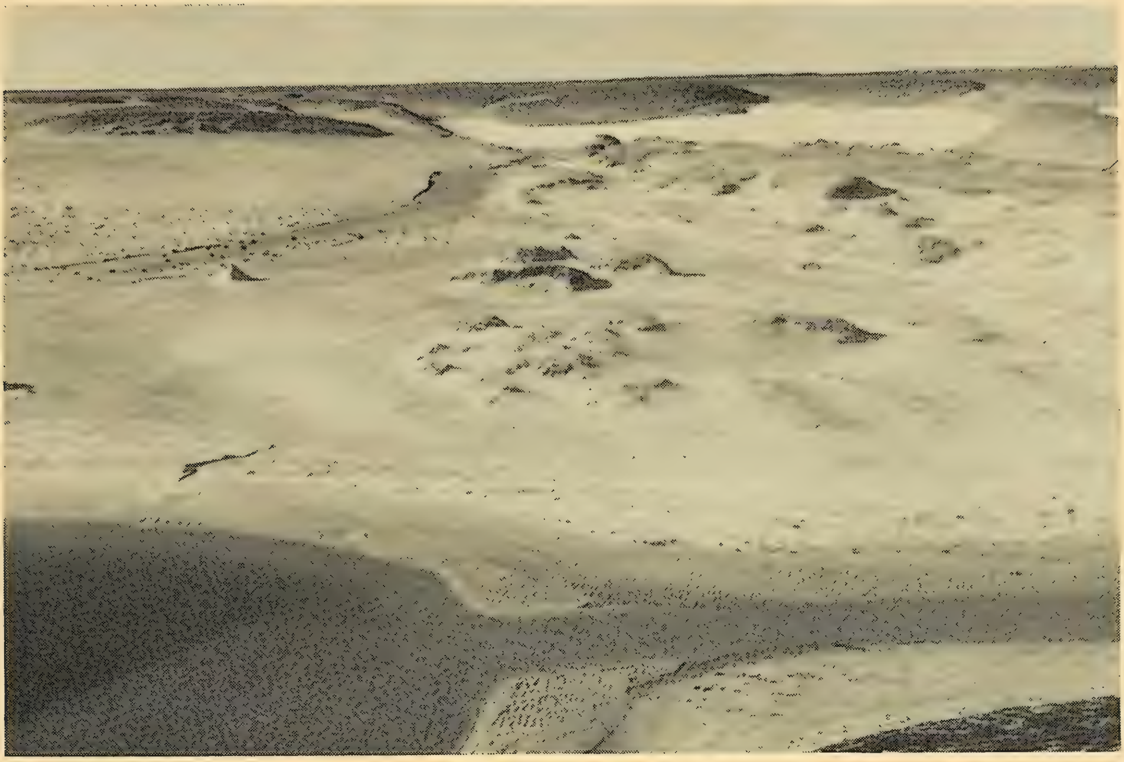

FIGURE 2. A view of a portion of the edge of the outwash plain in the Pelly Lake study area.

Vegetation: General Description

Large areas of the outwash plain are relatively flat and covered with vegetation, principally tufts of *Hierochloe alpina* in a continuous lichen carpet of *Alectoria nitidula* and *A. ochroleuca.* Slopes often lack vegetation, particularly those with a southwest exposure, while slopes with a northern exposure often are covered with a more or less continuous plant cover in which the dominant higher plant species usually include *Ledum decumbens, Cassiope tetragona, Vaccinum Vitis-idaea,* and *Hierochloe alpina* with a rich lichen complement of *Alectoria ochroleuca, A. nitidula, Cetraria cucullata, C. nivalis,* and *Cladonia alpestris.*

Some degree of solifluction activity usually is in evidence near the summits of these slopes, and the exposed surface material, often lag gravel and coarse sand, is frequently undergoing recolonization by the lichen components of the community, chiefly the *Alectoria,* with an occasional tuft of a *Carex* species, as well as *Silene aculis, Luzula confusa, Saxifraga tricuspidata,* and *Hierochloe.*

Low flat areas such as the extremely gentle slopes around margins of small ponds are often covered with a continuous mat of vegetation, principally *Carex* and *Eriophorum* species, with the more abundant Ericaceous specis such as *Ledum decumbens, Vaccinium Vitis-idaea,* and *Andromeda polifolia* found on areas slightly elevated above the general level of the meadow. Frost activity often is in evidence on these low sites, particularly in the form of relatively slightly developed raised-center polygons. In the drainage lines leading from more upland slopes into the lower meadows, *Cassiope* is much in evidence, apparently favoring depressions with slightly

greater moisture supplies than the flatter, more upland sites, and also occupying areas on which snow patches are found. Other species occupying lower areas most frequently include *Ledum decumbens, Luzula spadicea,* and an assortment of lichens and mosses, as well as *Vaccinium Vitis-idaea.*

Bare sand summits of the outwash and esker systems are often apparently undergoing colonization by *Poa arctica, Calamagrostis* spp, and *Arctagrostis latifolia,* in addition to *Carex* and *Luzula* species and *Polytrichum.* Lag gravel on similar topographic sites is often being colonized by *Alectoria, Cetraria, Silene, Carex,* and *Polytrichum* species, as well as by *Empetrum nigrum, Vaccinium Vitis-idaea, Betula glandulosa,* and *Ledum decumbens* in descending order of abundance, and more rarely by *Potentilla* species.

It appears that tussock muskeg communities, such as those described in some detail in the Ennadai Lake area vegetation (Larsen 1965), are poorly developed in the Pelly Lake area, even in those sites which are transitional between low meadows and rock fields, the specific topographical position where they attained their most advanced stage of development around Ennadai Lake.

While such a categorization as that constructed above is necessarily an arbitrary one, with all stages and grades of difference existing along a continum, the following major community types can be taken as nodal, with each occupying a relatively large proportion of the terrain in the Pelly Lake area:

Outwash plain communities:
1. Summit.
    A. Sand surface (flat).
    B. Lag gravel surface (flat).
2. Slopes.
    A. Southern exposure.
    B. Northern exposure.
    C. Drainage and late snow patch areas.
3. Low Meadow.

Glacial drift communities:
1. Rock field.
2. Low meadow.

Aquatic Communities:
1. Lake shore.
2. Stream borders.

Phenology

Upon our arrival at Pelly lake on June 18, the breakup had progressed to the point where open water was prevalent in the small tundra ponds and rivulets of water were to be found in every drainage line. The snow had completely disappeared over the broad, flat areas of tundra, although late snow patches in ravines and other small depressions were to be seen everywhere. On June 20, three species were found in bloom, the earliest of the spring flowering plants; *Arctous alpina, Hierochloe alpina,* and a *Potentilla* species. Large flies appeared for the first time in numbers on our meat strips hung for drying and the first mosquito was seen. Five eggs were observed in a Lapland longspur nest and two caterpillers and a few bees were observed. A half dozen Canada geese were flushed during a walk over the tundra. The only evidence of mammalian life at this time was a lone wolf seen the first day after our arrival and a few scattered wolf tracks as well as relatively recent musk ox and caribou tracks. Later in the summer, additional wolves and a few caribou were observed, but animal densities were generally low. By comparison with other areas studied in previous years, the descriptive term barrens is an exceedingly apt one here.

The following dates of significance are given as noted:

June 29. First leaves of *Rubus Chamaemorus* seen in low meadow on outwash plain. *Salix arctica* catkins visible and leaves unfolding on outwash plain meadow and a *Carex* in flower.

July 1. *Silene acaulis* has been in bloom several days, as have *Cassiope* and *Ledum.* Lapland longspur nest is discovered with two nestlings and two unhatched eggs. A *Pedicularis* spp. is in bloom for first time. The *Carex* and

FIGURE 3. A view of a portion of the outwash plain summit occupied by the tufts of *Hierochloe alpina* and the *Alectoria* species in the distinctive community found on such sites.

Eriophorum in the meadows are still not identifiable from inflorescences of the current season. Most have only the beginnings of green coloration where new leaves have begun to appear.

July 2. The small lake northeast of camp is now ice free excepting for a remnant on the windward (SE) shore.

July 8. First *Rubus Chamaemorus* in bloom; first *Polygonum viviparum* flowering scape seen; another *Pedicularis* spp. in bloom. Ice nearly gone from north arm of Pelly Lake, although it still remains in piles along shore where blown by the wind.

Community Descriptions

Outwash Plain Summit

Without doubt the most interesting and unusual community in the Pelly Lake area is that found on the relatively flat summit of the outwash plain, a xeric environment and one in which the substrate of coarse sand and gravel affords little retention possibilities for the small amounts of moisture available (Fig. 3). These areas are occupied by a community in which two lichen species are by far the dominants, and these are *Alectoria ochroleuca* and *A. nitidula,* the latter a dark brown, nearly black species perhaps adapted in this manner for the capture of as much radiation as possible during brief periods when moisture available will permit metabolism. At most times, *Alectoria* is so dry as to crunch perceptably underfoot, and evidently can be metabolically active only during brief periods during and immediately following the relatively rare precipitation or, perhaps more frequently, when dew condenses on the thalli. The only species of higher plants found in abundance in this community are *Hierochloe alpina, Luzula confusa, Ledum*

FIGURE 4. A lag gravel ridge summit in the Pelly Lake area (right) with a wet swale in a depression (left center).

decumbens, Cassiope tetragona, and *Vaccinium Vitis-idaea.* The three latter species appear to occupy the areas where micro-variations in the terrain have produced moisture retention greater than over most of the area, and in such areas *Alectoria ochroleuca* appears to be more abundant in terms of cover than *A. nitidula.* These species, for example, are found in the slight depressions of the polygon net and in the shallow, poorly developed drainage lines. In such areas, too, there appears to be a larger proportion of finer material in the soil profile. A sandy surface is not essential for the development of this community, as is shown by transects #9-17 and #9-18 which were run on a rocky summit of the plain between two major drainage lines, one of which is now occupied by a stream, the other showing evidence of having been active in immediate postglacial time and which is now occupied by small lakes and ponds. A series of beach ridges is also apparent here, having been formed as the water in the basin drained and declined to successively lower levels, apparently in response to melting of glacial ice dams blocking the Back River basin (Craig 1964). On these ridges, communities of a composition intermediate between the rock fields and dry slopes are to be found. (Stand #9-20).

The ecology of the *Alectoria* is of particular interest since the black coloration must have adaptive and survival value. It was noted that in early morning the mat of *Alectoria* has absorbed sufficient moisture to have become quite soft and pliable, in contrast to the singularly crisp, brittle state often encountered during the day. It is conceivable that the high absorptivity of radiation by black thalli raises the temperature of the lichen, even under the reduced light conditions of early morning, to

permit photosynthesis and other physiological processes. Whatever the actual circumstances under which it occurs, moisture absorption from the atmosphere and utilization of the radiation capturing capacities of the black pigmentation must account for the apparent success of this lichen in colonizing the most arid, windswept, and variable environment (in terms of temperature) to be found in the area.

The field work at Pelly Lake was conducted early in the season. A number of regular species components of the various associations may not have come into leaf, much less flower, at the time the transects were run. *Rubus Chamaemorus, Arctagrostis,* and *Calamagrostis* are probably among these species, as are some of *Carex*. It is believed, however, that these consitute minor omissions in at least most instances and that the various associations are adequately represented by the data presented (see Tables).

Slopes with North Exposure

On the outwash plain, slopes facing northward are those with the most dense vegetational mat. Here the moisture supply is sufficient, to all appearances (since it is evidently the limiting factor in the outwash plain communities), to support a relatively dense vegetation, of which a high proportion of the cover is contributed by higher plants in contrast to the summit of the flatter areas of the plain where the two *Alectoria* species constitute the dominants. On the northward facing slopes, *Cassiope tetragona* and *Ledum decumbens* are dominants, with *Vaccinium Vitis-idaea, Empetrum,* and *Vaccinium Vitis Idaea* in equally high frequency, but visibly not as prevalent as lichens.

This community is apparently present in response to the moisture conditions, since it is found on slopes where at this time of year (June 21) late snow patches are everywhere in evidence and the most dense representation of *Cassiope* and *Ledum* occurs near the edge of the snow. The community at this time can be seen to continue beneath the snow bank, on the slopes both above and below the accumulated snow. Meltwater from snow can be seen flowing through the plant community but moisture is also evidently sufficiently abundant above the snow to support the same community since differences in composition and species frequency in transects above and below the snow bank are slight.

In topographic position this community is similar to that found on the north-facing slopes at Ennadai Lake (Larsen 1965) but the presence of *Cassiope* in high frequencies is a major distinguishing characteristic of this community located some 350 miles north of Ennadai.

Lag Gravel Community

On the summit of some of the higher elevations, lag gravel rather than sand constitutes the surface material, particularly on sharp ridges and pointed hills, and these sites (Fig. 4) are occupied by a rather distinct community. Such species as *Potentilla* spp, *Silene acaulis, Alectoria nitidula* and *A. ochroleuca,* are dominants (although *A. ochroleuca* is visibly reduced in proportion of cover in comparison with the sandy flat outwash summit), and *Salix arctica* and *Dryas integrifolia* are to be found although they do not constitute abundant species. *Dryas,* however, becomes more frequent at the lower edges of the gravel where it grades visibly into a slope with finer substrate material on which *Ledum, Cassiope, Vaccinium Vitis-idaea, Empetrum,* and *Vaccinium uliginosum* become abundant, and mosses other than *Polytrichum* occur. Here the *Alectoria ochroleuca* is more abundant than *A. nitidula,* giving the community a much lighter overall coloration than either the lag gravel or outwash sandy plain community. *Cetraria nivalis* and *C. cucullata* are also frequent associates.

Shallow drainage lines in the lag gravel areas often contain a high frequency of *Cassiope* and *Ledum* and in small, wet depressions or around pools, *Salix herbacea* and *Pyrola grandiflora* occur along with *Sphagnum* mosses.

Rock Field Community

This community is found most frequently on drumlinoid forms composed of glacial till,

and is characterized by a relatively long species list representing principally the Ericaceae, Carices, and grasses. The surface of the substrate is markedly rocky and gravelly, including a high proportion of rocks of boulder size with exposed surfaces breaking the continuity of the gravel. There is a tendency for higher densities of *Ledum* and *Cassiope* to occur around the periphery of these exposed rocks and in the shallow drainage lines often produced by development of polygons or, more often, simple linear fissures and other poorly developed polygonal markings (Cook 1959).

Several distinct features of the rock field communities at Pelly Lake were noted. In comparison to more southern study areas, such as Ennadai Lake, as well as the Aylmer-Clinton Colden-Artillery Lakes area, *Arctous alpina* and *Vaccinium uligonisum* are uncommon, *Betula glandulosa* appears rarely. On the other hand, *Cassiope* appears on the moister sites, a species which does not occur in transects at Ennadai or the Lockhart basin, and this species is joined by *Diapensia* and *Silene,* as well as *Armeria,* in the rock fields at Pelly Lake, adding a further distinctive character to these latter communities. In addition, on the highest rock field drumlinoids, *Alectoria ochroleuca* and *A. nitidula* appear with high frequency, evidently finding here conditions similar to the sandy outwash plain described previously.

On June 25, the depth of the active layer on the rock field was approximately 18 inches as discerned in a number of soil pits. Mud boils were frequent on the lower slopes of the rock fields where the latter grade into low meadows, and on such areas, where small pools are often present, *Cassiope* is a member of the rock field vegetational community. It is of some interest that this species occurs in nearly all communities, but rather obviously has a definite range of moisture conditions which it can tolerate; it thus appears in the wetter areas on the outwash plain and rock fields, and the drier areas of the wet meadows, but not on the dry portions of the rock fields nor in the wettest meadows. The rock fields, in general, have maximum slopes ranging upward to 5° of slope with as much as 8° attained rarely. Frost action such as mud boils have resulted in what might be termed a micro-terracing in some lower areas, with formation of small depressions capable of retaining water; hence, many rock field areas are relatively moist, at least during periods of snow melt or rain fall. These conditions evidently afford sufficient moisture for *Cassiope.* By contrast, *Rhododendron lapponicum* appears only on the summits of the highest rock fields, being found with *Hierochloe, Vaccinium Vitis-idaea,* and the two *Alectoria* species on such sites.

Dry Slope Community on Outwash Plain

Two distinct community types are included under this heading, the one possibly a "subclimax" type represented by stand #9–12 and the other a successional stage represented by stand #9–11, the two occurring in close juxtaposition on an area which apparently once supported an outwash plain *Hierochloe-Alectoria* community (see text and Fig. 3) and which subsequently was disturbed by a jeep trail. To the north of this trail the original community still exists undisturbed while to the south of it the *Alectoria* mat has been dislodged and, over much of the area, blown away or desiccated and buried by a shallow sand deposit. It appears that this latter community can be considered a successional stage pioneering sand and coming into the area where the *Alectoria* mat has been destroyed. *Polytrichum* in pure stand is a pioneer on some sandy areas, from a distance lending a characteristic and particularly conspicuous orange-brown color to these sites.

In a wet swale, species represented included *Eriophorum spissum, E. angustifolium, Potentilla palustris, Salix arctophila, Carex stans, Polygonum viviparum,* and moss spp.

Low Wet Meadow

Low wet meadow occupies the flat portions of the terrain where the water table is above the surface during spring and early summer and is never more than a few inches below the surface by the latter part of the summer. Although the low meadow is characterized by an assemblage of dominants which are relatively

FIGURE 5. A view of the Snow Bunting Lake campsite and the rolling hills characteristic of the area.

uniform in their frequency of occurrence from one meadow to another, *Eriophorum* tussocks *(E. spissum)* occur in some areas in relatively pure stand.

Sandy Shorelines and Beaches

Pioneer species colonizing flat areas above the beachlines include *Carex stans* and *C. Bigelowii* with scattered patches of *Empetrum, Vaccinium uliginosum,* and occasional tufts of *Cassiope.* Lichens are relatively abundant, principally *Alectoria nitidula,* which grow around the *Carex* tufts. *Stellaria longipes* and a *Pedicularis* are less frequent but often present, and occur in some evidently rather special sites. *Rubus Chamaemorus* forms small beds.

Discussion

As noted in the studies of many other arctic areas, the plant communities of the Pelly Lake area appear to be strongly controlled by topography, which appears, further, to be the consequence of rather markedly differing moisture regimes from one topographical position to another. Small differences in elevation within a restricted area can be seen to have a pronounced effect on the plant association, with abrupt and readily visible boundaries where there occur differences in elevation of as little as six inches or less.

These differences in elevation may be the consequence of the original distribution of the glacial till or glaciofluvial sand, but may also frequently be the result of frost action and surficial molding characteristic of arctic regions. Minor soil differences, in terms of texture and composition, can be discerned upon close inspection and it would appear, at least from observational evidence, that the differences in moisture regimes, rather than other soil differences, account in large part of the relatively consistent occupancy of the various topographic sites by a distinct and characteristic aggregation

FIGURE 6. A view of the community, composed principally of tufts of *Hierochloe alpina* and *Alectoria* species, occuping portions of the hill slopes in the Snow Bunting Lake area.

of species. Disturbance, other that that which occurs as a consequence of frost action, has been minimal. On most of the terrain, the plant communities to be found today give the appearance of having persisted in their present form for long periods of time. This is true particularly in the case of the *Alectoria* mat on the flat surfaces of the sandy outwash plain, the rock field communities, and the low meadows. In each, it is apparent that the community must have existed for a long time to have reached its present state of development; for example, the *Alectoria* mat must of necessity be slow-growing in this climatic regime, yet despite this, it is thick and dense and obviously of some considerable age. On the rock fields, the individuals of *Ledum, Salix,* and other genera are sufficiently large and well-developed to provide assurance of considerable age.

Discussions of climax community types in arctic regions are necessarily arbitrary in nature (Churchill and Hansen 1958; Britton 1966). If an assessment is to be made, it probably should be that each community represents climax for its topographic position, and that for any forseeable length of time will continue to do so, hence supporting the polyclimax concept in application to this region. Within each of the major community ("subclimax") types, variation will be in response to the rather small differences in topography and, hence, moisture regime, much of which may be due to frost phenomena. Because of the virtually absolute control of communities by topography, the rock field and low meadow communities give every indication of a long continuous existence, largely undisturbed by anything other than frost action, and even this appears minimal on the extreme summits of the rock fields and the

central zones of the meadows. The flat sandy surface of the outwash plain summit, however, shows several marked frost features, notably the development of a fairly well developed and characteristic ice wedge form which might be described as corresponding to what usually are termed polygon nets.

Lichen growth on rocks indicates a relatively long period of exposure. In some instances a rock ejected by severe frost pressure from the subsoil shows a lack of any lichen growth on the exposed lower portion.

SNOW BUNTING LAKE SITE
(94°25'W; 66°10'N)

General

The Snow Bunting Lake study area is located about 55 miles southwest of McKay Peak, the point at which the Back River enters Franklin Lake. The surficial geology here is apparently typical of large areas of the central Canadian interior plains, with an abundant variety of glacial landforms (Craig 1961), particularly sandy eskers and rock fields formed of large, coarse, generally angular boulders. Most of the area is covered with drift, as described by Craig, ranging in size and texture from sand and gravel to large boulders, but to the east of the lake a few *roche moutonnier* outcrops occur.

In general appearance, the landscape is gently rolling (Fig. 5). The few rougher, more rugged rock fields and outcropping surfaces noticeably break the smoother surface features. Lakes and ponds are common, often linked by small streams flowing through shallow immature channels. Snow Bunting Lake forms the headwater of the Quoich River, and is located roughly on the height of land between the watersheds of streams flowing south into Baker Lake and north or northwest into the Back

FIGURE 7. A rocky hill summit in the Curtis Lake study area. The eastern end of Curtis Lake is shown in the background.

River, Chantry Inlet, and the Arctic Ocean. Elevation above sea level is between 1150 and 1250 feet (National Topographic Survey, Chantry Inlet, N.W. 66/96).

A field camp was established on the shore of Snow Bunting Lake on June 23 and maintained until mid-July. Some indication as to the annual variation in weather can be obtained from the observation that a deep snow bank just behind the campsite was observed on July 29, 1959; at the time of our arrival at the campsite in 1966 the bank had disappeared and apparently had been gone for some time since the entire area was quite dry.

Vegetation: General Description

As in the Pelly Lake area, the conspicuous feature of the vegetation is the dense carpet of lichen growth which covers the ground on such favorable sites as rock fields, esker summits, and esker slopes with a southward-facing exposure (Fig. 6). The communities of the rock field summits and the esker summits are dominated by *Alectoria nitidula* and *A. ochroleuca* as on the flat surfaces of the outwash and the rock fields at Pelly Lake. Lowland rock fields and upland gentle slopes with moderate drainage, however, have a dense lichen carpet in which these *Alectoria* species are minor components, and where *Cladonia* species attain dominance (See #9-28 for species list) along with *Cetraria*. In each of these community types, *Rhacomitrium lanuginosum* is a conspicuous component, at times occupying areas in nearly pure stand as large as five to ten or more square feet. Even more extensive beds were found occasionally on the lower portions of the dry esker slopes. The much smaller tufts of *Polytrichum*, however, attained greater frequency in quadrat data obtained from these areas.

The following major community types might be taken as nodal, with each occupying a relatively large proportion of the terrain in the Snow Bunting Lake area:

Esker Communities
1. Summit.
    - A. Sand surface (flat).
    - B. Lag gravel surface (flat).
2. Slope.
    - A. Southern exposure.
    - B. Northern exposure.
    - C. Drainage and late snow patch areas.
3. Low Meadow.

Glacial Drift Communities:
1. Rock field.
2. Low meadow.

Aquatic Communities:
1. Lake shore.
2. Stream borders.

Esker Summits

The esker summits are occupied by what are essentially pioneer species colonizing a lag gravel surface which is both dry and windswept and which appears to afford the environment which is the most inimical to survival in the area. Large areas of surface are virtually devoid of vegetation, but other portions possess a community in which dominant species are *Alectoria nitidula* and *A. ochroleuca* interspersed with *Hierochloe alpina* and the other species recorded. It might be noted that transect #9-34 is representative of the association pioneering bare lag gravel on the windswept esker summits, as indicated by the 100% frequency of bare gravel in the quadrat data. *Stereocaulon* is a common lichen.

Rock fields

Most rock fields have a continuous carpet of lichens, principally *Alectoria nitidula* and *A. ochroleuca,* but one transect, #9-37, records species on a low rocky ridge which lacks the continuous carpet, although both lichen species attain 100% frequency in the 1 m^2 quadrats. In other transects, *Cladonia* species contribute significantly to the lichen mat. Very low numbers of caribou possibly help account for the relatively advanced state of development of lichen growth on these areas.

After a brief rain, the low rock field community type was very moist for a period of several days; in this respect differing markedly

from the summit rock fields, the esker sites, and the outwash summit types (at Pelly Lake). This apparently is the major environmental difference between sites, on the latter of which are found the dark *Alectoria* communities and on the former the yellow *Cetraria-Cladonia* community which gives the area a distinctly light coloration.

Esker Slopes

Esker slopes frequently are the site of snow accumulation to some depth during winter and, hence, of relatively higher moisture content later into the spring than esker summits, particularly in the areas immediately around late snow banks. Although later in summer they appear dry as esker summits, the modified moisture regime in spring apparently accounts in significant fashion for the community differences between the topographic sites. *Cassiope,* in particular, appears responsive to the late snow patch environment, since only here and on some rock field areas where spring moisture supplies would also appear to be relatively high does it attain high frequency.

The turfy lower portions of the slopes are occupied by an association represented in transect #9-32, and the upper slopes, just beneath the lag gravel, by the association recorded in transect #9-33. Both communities are found on the north and northwest facing slopes. Esker slopes with southern exposure tend to be thinly vegetated and often are bare of vegetation altogether.

Low Meadow

The species composition of no other community appears as closely controlled by microtopography as that of the low meadows, for here differences in elevation of a few centimeters put the surface of the ground above or below the average summer position of the water table and, thus determine whether the association will be dominated by *Carex stans* (where the surface is below the water table) as in transect #9-36 or whether it will be composed of the larger number of species, as recorded in transect #9-35, capable of survival through a few weeks in spring when they are inundated and into summer and fall when the surface of the ground is moist but not saturated. Not recorded in transects were areas, often within or adjacent to communities similar to #9-35, in which tussocks of *Eriophorum spissum* comprise virtually the only species present. This species was also found around ponds in the low meadows, in association primarily with *Carex stans,* grasses, and mosses, principally *Sphagnum.* It is of interest that no *Salix* species are found commonly in meadows, with the exception of *Salix herbacea;* in this respect, the association differs markedly from that found on similar topographic sites farther south where *Salix arctophila* is a frequent associate. *Sphagnum* hummocks in meadows are occupied by species such as *Cassiope, Ledum, Vaccinium Vitis-idaea,* and other species often found more abundantly on drier sites.

Discussion

The highest esker ridge exposures are almost invariably lag gravel, either unvegetated or pioneered by *Polytrichum, Alectoria nitidula, Hierochloe alpina, Festuca brachyphylla, Potentilla* spp, and *Saxifraga tricuspidata,* with an aggregation of *Cetraria* and *Cladonia* lichen species and also including *Stereocaulon* and *Alectoria ochroleuca.* Flatter summit areas are occupied by the *Alectoria-Hierochloe* community with lighter-colored, yellowish zones following the shallow drainage and polygon net surface features; these latter take their color from *Cetraria* species, along with which are found commonly the species *Cassiope tetragona, Ledum decumbens,* and *Vaccinium Vitis-idaea.* A turfy esker community (#9-44) is found often along the lower edge of the *Alectoria* carpet, and here the Ericaceous species are found in abundance, with *Salix arctica, Carex* spp., *Cassiope,* and *Salix herbacea.*

The lower, more highly developed drainage lines are occupied by *Sphagnum* and other mosses, with *Saxifraga foliolosa, S. cernua, Cassiope, Carex,* and *Eriophorum* species. The rock fields possess communities similar in many respects to the flat summit areas of the eskers,

modified to some extent by the greater moisture retention of the rocky, uneven surface, with a consequent higher representation of the Ericaceous shrubs. On gentle rocky slopes, not as rough in surface aspect as the rock field summits, is found the *Cetraria-Cladonia* community, a dense surface mat of lichens along with a high frequency of *Carex Bigelowii*. *Salix herbacae* often occupies the moss hummocks which rise as little as a centimeter or less above surface level of the vegetational mat. Several grass species and *Cassiope* occur with somewhat lower frequency.

This latter association often grades into low meadow on areas where the water table approaches or reaches the surface and in these latter communities are found *Eriophorum* spp., *Carex stans,* grasses and occasionally *Saxifraga foliolosa* and *S. cernua*. *Carex stans* and grasses line the turfy shores of the ponds in meadows. Probably by far the greater proportion of the whole landscape in the area is occupied by the *Cetraria-Cladonia* and low meadow communities and various transitional stages between the two. There is rarely a sharp demarcation between these communities and only when topography is rough and the relief relatively abrupt do the community types show striking and narrow transition zones.

Streamside species principally include *Arctagrostis latifolia, Eriophorum* spp., *Sphagnum, Saxifraga foliolosa, Luzula spadicea,* with occasional *Salix herbacea* and grasses.

CURTIS LAKE AND REPULSE BAY (66°50'N; 88°55'W and 66°31'N; 86°15'W)

General

The Curtis Lake area is located only about 75 miles west northwest of Repulse Bay and about an equal distance northeast of the west end of Wager Bay, on terrain which might be described as rolling interior uplands, principally drift-covered, but with a relatively large proportion of the surface given over to out-cropping ridges, rocky hills, and *roches moutonnier* (Fig. 7). The highest hills, at times steep and craggy, extend to an elevation of more than 500 feet above the surface of the lake. Large numbers of ice-rafted boulders now rest randomly over the surface of the terrain, attesting to submergence during a post-glacial period. Excepting for the somewhat more rugged appearance resulting from jagged out-cropping hills, the region resembles the Snow Bunting Lake study area in its variety of glacial landforms. In contrast to the latter area, however, the Curtis Lake study site contains a number of permanent snow banks, resting in the deeper declivities of drainage lines and on beds of boulders from which the finer particles have been removed by the meltwater streams (Fig. 8).

There were no well-developed eskers in the study area, only low sandy hills covered with a virtually bare lag gravel surface. Eskers seen from the air, some ten or more miles west of the camp, appeared largely devoid of vegetative cover on summits and upper slopes.

The Repulse Bay area is characterized by rocky outcropping hills and rolling hills of glacial drift, the latter somewhat reduced in total extent of surface area compared to the other study areas. The irregular terrain probably accounts for the size and number of late snow patches and permanent snow banks persisting throughout the summer, all of which occupy south-facing cliff bases near which frequently a rather rich and turfy lichen and higher plant community is found. Probably the continuous moisture supply, in addition to frequent fogs, account for the relatively lush communities found in the area, contrasting with the inland area just described.

Communities studied at Curtis Lake and Repulse Bay can be categorized according to the following topographic positions:

Glacial Drift Communities:

1. Rock field.
   - A. Summit low hills.
   - B. Summit high hills.
   - C. Dry slopes.
   - D. Lower turfy slopes.
2. Low meadows.
3. Outcrop hills and ridges.
4. Late snow patches in rock field declivities.

FIGURE 8. Edge of a late snow patch area in the Curtis Lake area (long probe and shovel at right center). This is the bed of a stream originating in a permanent snow bank.

Aquatic Communities:

1. Streamside.
2. Lakeside.

The marked floristic simplicity of the vegetational associations is perhaps the most notable botanical feature of both areas. There are relatively few species represented on rock fields and sand and gravel flats, the number of possible associations, employing the methods of topographic delineation, are few.

No eskers exist in the study areas, but outwash aprons are extensive, possessing largely a lag gravel surface either bare or very sparsely vegetated. The *Alectoria-Hierochloe* community is well-developed upon exposed sandy upland flats and gently sloping areas.

Rock Field

The surface material of the rock field summits is primarily sand and gravel with an average of 10-25% bare exposed rock surface, and with a relatively high proportion of the remaining surface characterized by evidence of surficial frost activity. *Saxifraga octopetala* is relatively common in the central zones of stable mud boil sites, as are *Silene acaulis,* and less frequently *Carex stans. Ledum decumbens* is found in sheltered spots around rocks. *Carex nardina* and *C. Bigelowii* are relatively common, along with *Polytrichum* and other mosses, and 100% frequency in 1 m^2 quadrats was attained by such lichen species as *Alectoria nitidula, A. ochroleuca, Cetraria cucullata,* and *Cladonia* species. *Hierochloe alpina* is distributed widely in the rock field communities.

Late snow patches on slopes of deeper drainage lines, gullies, or at the base of cliffs, usually face south, indicating predominantly north winds during winter with snow accumulations on the leeward slopes.

FIGURE 9. The view above is that of a large, nearly flat area in the Curtis Lake vicinity (foreground) with slopes rising to rock fields (background).

The dry slope might be considered a rock field variation in which gently sloping or nearly flat (Fig. 9) sand and gravel are admixed with a much lower frequency of boulders. These slopes and flats are dry on upper levels by August (the camp was located at Curtis Lake during the period August 6-20 and at Repulse Bay for ten days thereafter). On the lower levels, *Carex* (principally *C. Bigelowii*) and *Eriophorum* spp. are of high frequency. *Salix reticulata* was also found here, the only site that this species was seen to occupy in the Curtis Lake area.

There appears to be a rather large variation in water retention on dry slopes due to drainage patterns and topographic position. Transect #9-57 is on dry sand, probably dry most of the time excepting in very early spring. Transect #9-58 is relatively dry by August, but would likely be subjected to sheet drainage during most of the early summer. The slope has a terraced appearance because of polygons which tend to have horizontal surfaces.

A relatively large proportion (ca. 10-15%) of the terrain in the Curtis Lake study area is given over to this topographic type, a proportion greater than in any other study area. In many respects this constitutes a unique landform and presents a correspondingly unique plant community, although similar in many respects to dry slopes of other areas. A noted difference, however, was the absence of *Empetrum* in the Curtis Lake area on this topographic site.

The *Cetraria-Cladonia* community is represented at Curtis Lake, as at Snow Bunting: one small patch was found, not sufficiently large to furnish transect data. None were seen elsewhere over a relatively large area.

Tables

Tabulated data in all instances is the frequency of occurrence of the designated species in transects composed of 20 quadrats; each quadrat is one square meter in shape and size and is located equidistant from other quadrats (usually 20 paces apart) along a compass line through the designated community.

TABLE 1. — Northern Keewatin, (all areas) — low meadow community: angiosperms

Stand	Pelly			Snow Bunting				Curtis	Repulse					
	9-22	9-24	9-25	9-35	9-36	9-39	9-40	9-48	9-62	9-64	9-66	9-69	9-70	9-71
Species														
Andromeda polifolia	65	35	15											
Arctagrostis latifolia	5			20			10		15	5	35	5		
Betula glandulosa	40	15												
Carex atrofusca									55		35	35	50	15
Carex chordorrhiza		20	50						5					
Carex membranacea									15	5	30	5	25	
Carex rariflora	30	50												
Carex rotundata	20	40	45			5								
Carex. sp./spp.	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Carex stans	70	20	10	5	80		10	10	50	90	45	95	45	
Cassiope tetragona	5	5				50							20	10
Chrysanthemum integrifolium											65		20	10
Dryas integrifolia						30			25			40	90	100
Equisetum scirpoidea									20		65	30	20	
Eriophorum augustifolium		5	15	10	30		15	25	50		10			
Eriophorum spissum	25	35	35	30	10	20	5	55						
Grass sp./spp.				45	25		10			5				
Juncus biglumis				5						5		5		
Kobresia simplisciula									5		25	10	10	
Ledum decumbens	75	40	35			15								
Luzula confusa	5							10						
Luzula spadicea	5	5	5			40	5							
Lychnis apetala									5	20		10		
Lycopodium selago		10				5								
Oxytropis arctica									25	20		20		85
Pedicularis sudetica	5	5							10		20	35		20
Poa sp.	5			30	10	5			5					5
Polygonum viviparum	5	25	5					10	10		20			55
Salix arbutifolia	85	65	80			5					5			
Salix arctica										20			35	100
Salix arctophila									30		55		35	
Salix calcicola									20				50	
Salix herbacea	5	15		55		85	15	15						
Salix reticulata												5	35	50
Saxifraga cernua				15			10							
Saxifraga foliolosa		5	5	25	25	20	30	50						
Saxifraga oppositifolia											25		30	90
Vaccinium uliginosum	10	25				10								
Vaccinium vitis-idaea	60	15	15			30								

Additional species noted: Carex vaginatum, Pedicularis labradorica, Empetrum nigrum, Rubus chamaemorus (Pelly Lake); Luzula nivalis (Curtis Lake); Kobresia myosuroides, Parrya arctica, Papaver radicatum, Ranunculus sp., Saxifraga hirculus, Pedicularis sp., Woodsia glabella, Carex misandra, Potentilla nivea, Pedicularis lanata, Carex scirpoidea, Rhododendron lapponicum (Repulse Bay), Equisetum variegatum, Carex capillaris, Epilobium davuricum, Salix sp.

TABLE 2. — Curtis Lake — Rock field community: Angiosperms

Stand	9-46 DS*	9-47	9-49	9-50	9-51	9-53	9-54 DS	9-55	9-56 DS	9-57 DS	9-58 DS	9-59	9-60
Species													
Arctagrostis latifolia		5					20			5	5		
Carex bigelowii		10			35	10		5					
Carex sp/spp	25	15	60	10	65	45	100	95	100		100	60	25
Cassiope tetragona	75	100	100	45	95	85		90	100	40	70	100	85
Dryas integrifolia			45		95		70	45	15		100	10	25
Epilobium davuricum										45	5		5
Eriophorum augustifolium								35					
Grass sp/spp	100	85	35	95	80	100	65			100	35	85	100
Hierochloe alpina			15	25		15	35	5		25	10	20	20
Ledum decombens						15		10				15	5
Luzula confusa	80	55	30	20	10	55	50	15	10	100	20	35	40
Luzula nivalis	45	25	15			5	25	10	35	30	15	40	20
Lycopodium selago	5	15	15				10	10	25		15		
Pedicularis lanata							5	5			5		
Pedicularis sp.		5							15				
Poa sp.							15				5	10	
Polygonum viviparum		20	20		50	5	15	25			55	10	
Potentilla vahliana				15						10	5		
Salix arctica		40	65	95		65	100	75	90	5	100	50	25
Salix herbacea			5				30		30	5	15	15	
Salix reticulata								10			60		
Saxifraga foliolosa	10								5				
Saxifraga oppositifolia					15	10		5			30		
Silene acaulis			45	70	70	10	75	5		40	85		10
Vaccinium uliginosum								10			10		

*DS refers to well-drained (dry) slope.
Additional species noted: Oxytropis arctica, Carex nardina, Draba sp., Carex membranacea, Carex scirpoidea, Papaver radicatum, Kobresia myosuroides, Carex rupestris, Juncus biglumis, Epilobium latifolium.

TABLE 3. — Rock field community: Angiosperms — Pelly Lake

Stand	9–3	9–4	9–5	9–6	9–7	9–12 DS	9–19 DS*	9–20	9–23 DS
Species									
Arctagrostis latifolia							20	10	5
Arctous alpina				5	5				15
Ameria maritima		25	40		15				
Carex bigelowii	20	60	40	35	25			10	35
Carex sp/spp	95	90	90	90	50	35	50	35	55
Cassiope tetragona	35	10	5	85		40	65		
Diapensia lapponica	5	10	40	25	5				5
Empetrum nigrum	15	60	70	70	15	100	100	5	95
Hierochloe alpina	80	75	80	30	70	80	55	100	45
Ledum decumbens	100	100	100	100	65	95	80	80	85
Luzula confusa	15	20	5		5	25	5	45	30
Poa	10						5		
Salix arctica	5	5							40
Salix brachycarpa var. niph.					30				
Salix herbacea		10					50		25
Silene acaulis	30				40				20
Stellaria longipes					10				5
Vaccinium uliginosum		35	10	20			30		30
Vaccinium Vitis-Idaea	95	100	100	100	100		60	90	80

*Drainage line of dry slope.
Additional species noted: Antennaria sp., Betula glandulosa, Calamagrostis sp., Rhododendron lapponicum, Carex vaginatum, Carex rotundata, Carex atrofusca, Andromeda polifolia, Pedicularis sp., Salix planifolia.

TABLE 4. — Rock Field Community: Angiosperms
Repulse Bay

Stand	9–61	9–63	9–67
Species			
Chrysanthemum integrifolium	45	10	
Carex atrofusca		15	65
Carex misandra	30		
Carex sp/spp	100	95	100
Cassiope tetragona	35	95	25
Dryas integrifolia	100	95	100
Oxytropis arctica	75	75	100
Pedicularis sudetica		10	20
Polygonum viviparum	45	25	35
Salix arctica	55	40	25
Salix calcicola	10	5	5
Salix reticulata	25	95	35
Saxifraga oppositifolia	90	55	95
Vaccinium uliginosum	5	15	

Additional species noted: Potentilla vahliana, Pedicularis sp., Luzula nivalis, Carex stans, Pedicularis lanata, Draba sp., Carex membranaceae, Kobresia myosuroides, Tofieldia pusilla, Kobresia simplicuiscula, Carex atrofusca, Woodsia glabella, Epilobium latifolium, Salix arctophilia, Carex chordorrhiza, Saxifraga aizoides, Rhododendron lapponicum.

TABLE 5. — Snow Bunting Lake — Rock field community: Angiosperms

Stand	9–28	9–29	9–30	9–37	9–42	9–43 DS	9–44	9–45
Species								
Arctagrostis latifolia	35			5				
Carex sp./spp.	15		5		90	100	40	100
Cassiope tetragona	30	100	85	50	50	45	65	10
Dryas integrifolia	30			70	15	45	35	
Grass sp./spp.	100	95	100	100	60	55	95	55
Hierochloe alpina		10	20	5	5		15	
Ledum decumbens		70	75	40	5		20	
Luzula confusa	40	75	60	10			5	15
Luzula nivalis	15	5			5			
Poa sp.				10	35	30	15	5
Salix arctica	70			90	30	25	60	5
Salix herbacea	90				85	95	45	85
Stellaria longipes					5			
Vaccinium uliginosum				15			35	5
Vaccinium vitis-idaea	35	75	60	90	75	70	60	45

Additional species noted: Arctous alpina, Carex stans, Papaver radicatum, Draba sp., Lychnis apetala, Oxytropis alpinus, Polygonum viviparum, Saxifraga tricuspidata, Festuca brachyphylla, Pedicularis lanata, Epilobium davuricum, Eriophorum augustifolium, Carex bigelowii.

TABLE 6. — Lag gravel communities: Angiosperms

Stand	Pelly Lake			Snow Bunting 9–34	Repulse Bay 9–65
	9–9	9–10	9–15		
Species					
Agrostis borealis				10	
Antennaria sp.	5	20			
Arctous alpina	5	25			
Carex nardina				15	
Carex sp./spp.				55	100
Cassiope tetragona			5		
Cerastium alpinum			5		5
Draba sp.					10
Dryas integrifolia	10	30	75	25	100
Empetrum nigrum		45			
Grass sp./spp.				70	
Hierochloe alpina	30	5	50	15	
Ledum decumbens		5	5		
Luzula confusa				15	
Oxytropis arctica		10	35		70
Oxytropis maydelliana	40				
Poa arctica				35	
Poa sp.				25	
Polygonum viviparum					35
Potentilla nivea				85	
Potentilla sp.		15	50		30
Potentilla vahliana	100				25
Salix arctica			5	35	10
Saxifraga cernua				5	
Saxifraga oppositifolia					85
Saxifraga tricuspidata	80	25	5	45	
Silene acaulis	95	20	50	45	20
Stellaria longipes			5	5	
Vaccinium uliginosum		45			
Vaccinium vitis-idaea		70	5	10	

TABLE 7. — Late snow patch area — Curtis Lake

Stand	9–52
Species	
Carex sp./spp.	55
Cassiope tetragona	55
Grass sp./spp.	20
Luzula confusa	95
Luzula nivalis	5
Oxyria digyna	100
Potentilla sp.	5
Salix arctica	5
Salix herbacea	5
Saxifraga oppositifolia	5
Silene acaulis	40
Lichens	100
Mosses	100

TABLE 8. — Wet sphagnum slope* — Pelly Lake

Stand	9–21
Species	
Carex sp./spp.	100
Carex stans	10
Cassiope tetragona	70
Empetrum nigrum	20
Ledum decumbens	55
Salix herbacea	100
Vaccinium uliginosum	25
Vaccinium vitis-ideae	45
Lichens	30
Mosses	100
Sphognum sp./spp.	95

*Broad drainage area on outwash plain; a late snow patch area. Stereocaulon present but very infrequent.

TABLE 9. — Pelly Lake — Summit outwash plain: Angiosperms

Stand	9–1	9–2	9–8	9–11	9–13	9–14	9–16	9–17	9–18
Species									
Carex bigelowii						5		35	
Carex sp./spp.					10	25	25	40	10
Cassiope tetragona		100	35	30	70	25	45		20
Empetrum nigrum	5	5			10	5	5		
Grass sp./spp.	100	100	100	100	100	100	100	100	100
Hierochloe alpina	95	85	100	80	75	75	80	100	100
Ledum decumbens	35	100	65	95	100	70	85	65	45
Luzula confusa	15	50	45	55	30	50	20	20	20
Vaccinium vitis-idaea	35	100	65	95	100	70	85	65	45

Additional species noted: Lycopodium selago, Carex rotundata, Salix herbacea, Vaccinium uliginosum, Arctagrostis latifolia.

TABLE 10. — Snow Bunting Lake — Esker summit and slope: Angiosperms

Stand	9–26 Sm	9–27 Sm	9–31 Sl	9–32 Sl	9–33 Sl	9–38 Sl	9–41 Sl
Species							
Antennraia sp.			10		5		5
Arctagrostis latifolia	5	10	30	5	5	15	5
Carex bigelowii					5		10
Carex sp./spp.	10	20					45
Cassiope tetragona	25	65	100	100		100	25
Dryas integrifolia	10		35		50		20
Grass sp./spp.	85	100	100	100	85	95	25
Hierochloe alpina	50	60	10	55	35	20	15
Ledum decumbens	15	20	20				
Luzula confusa	35	75	30	45	10	95	10
Luzula nivalis				5		25	
Poa sp.	5		20		25	10	10
Polygonum viviparum		15	10				
Potentilla nivea	20		15				
Potentilla sp.					25		30
Pyrola secunda			15	20			
Silene acaulis		5	5				35
Salix arctica	5	20	80	15	5		
Salix herbacea		5	60	100	10	50	15
Saxifraga tricuspidata	5				50		5
Vaccinium vitis-idaea	70	40	40	85	85	95	15

Additional species noted: Armeria maritima, Stellaria longipes, Festuca brachyphylla, Epilobium davuricum, Papaver radicatum.

TABLE 11. — Rock field community: Lichens and mosses — Snow Bunting Lake

Stand	9–28	9–29	9–30	9–37	9–43	9–44	9–45
Species							
Alectoria nitidula	10	100	100	100	10	100	5
Alectoria ochroleuca	80	100	100	100	100	95	60
*Cetraria cucullata**	100	60	85		100		
*Cetraria nivalis**	90	40	30		80		
*Cladonia sp./spp.**	100	100	95		100		
*Cladonia alpestris**	35	90	55		unk.		
*Peltigera pulverulenta**	15	5	5				
Rhacomitrium lanuginosum	80	15	10	30	45		30
*Sphagnum sp./spp.**	50						
Lichens	100	100	100	100	100	100	100
Mosses	100	100	100	100	100	100	100

*Data taken only from stands 9–28, 9–29, 9–30, 9–43.

TABLE 12. — Rock Field Community: lichens and mosses — Repulse Bay

Stand	9–61	9–63	9–67
Species			
Alectoria nitidula	75		35
Alectoria ochroleuca	65		50
Rhacomitrium lanuginosum		15	10
Lichens	100	100	100
Mosses	20	55	60

TABLE 13. — Lag gravel communities: Mosses and lichens

Stand	Pelly Lake			Snow Bunting	Repulse Bay	
	9–9	9–10	9–15	9–34	9–65	9–68
Species						
Alectoria nitidula	95		100	90	90	100
Alectoria ochroleuca	90		90		90	100
Lichens	100	100	100	100	100	100
Mosses	75	100	100	95	100	95

TABLE 14. — Esker summit and slope: Lichens and mosses — Snow Bunting Lake

Stand	Summit		Slope				
	9–26	9–27	9–31	9–32	9–33	9–38	9–41
Species							
Alectoria nitidula	100	100					30
Alectoria ochroleuca	100	100					
Cetraria cucullata	95	100					
Cetraria nivalis	95	100					
Rhacomitrium	20						
Lichens	100	100	100	100	100	100	85
Mosses	100	100		100	100	100	95

TABLE 15. — Summit outwash plain: Lichens and mosses — Pelly Lake

Stand	9–1	9–2	9–8	9–11	9–13	9–14	9–16	9–17	9–18
Species									
Alectoria nitidula	100	95	100	55	100	90	100	100	100
Cetraria cucullata					90	95			
Cetraria nivalis					85	95			
Cladonia alpestris			55		50	10	100	40	60
Rhacomitrium				25					
Lichens	100	100	100	65	100	100	100	100	100
Mosses	60	40	85	90	100	95	100	100	100

TABLE 16. — Low meadow community: Lichens and mosses — All areas

Stand	9–22	9–24	9–25	9–35	9–36	9–39	9–40	9–48	9–62	9–64	9–69	9–70	9–71
Species													
Lichens	35	15	25	25	10	35	35	15	5	5	25	20	100
Mosses	100	90	95	100	100	100	100	100	100	100	100	100	40

TABLE 17. — Rock field community: Lichens and mosses — Pelly Lake

Stand	9–3	9–4	9–5	9–6	9–7	9–12	9–19	9–20	9–23
Species									
*Alectoria nitidula****					100	25		100	
*Alectoria ochroleuca***					70	30		100	
Cetraria cucullata						100		100	
Cetraria nivalis						100		100	
Rhacomitrium		40	30	60			5		
Lichens	100	100	100	100	100	100	100	100	95
Mosses	100	100	85	100	95	10	100	100	85

*Drainage line of dry slope.
**Data taken only from stands 9–7, 9–12, and 9–20.
***Including Alectoria nigricans and Cornicularia divergens.

Table 18. — Rock field community: Lichens and mosses — Curtis Lake

Stand	9-46	9-47	9-49	9-50	9-51	9-53	9-54	9-55	9-56	9-57	9-58	9-59	9-60
Species													
Alectoria nitidula	100	100	90	100	80	100		45		100	45		
Alectoria ochroleuca	100	100	85	100	80	100	10	60		100	60		
*Cetraria cucullata**	100	100	95	100			80	40		100			
*Cetraria nivalis**	100	95	60	100			10	25		100			
*Cladonia alpestris**	15	30											
*Cladonia sp./spp.**	85	95	65	100		100	45	65		100			
Rhacomitrium lanuginosum	10	50	40	15	55	20	80	40	45		40	80	25
Lichens	100	100	100	100	100	100	100	85	100	100	100	100	100
Mosses	100	100	100	100	100	100	100	100	100	100	100	100	100

*Data taken only in stands 9–46, 9-47, 9-49, 9-53, 9-54 9-55, 9-57.

Table 19. — Lichens in rock field transects

	Area and transect number										
	Pelly Lake		Snow Bunt.		Curtis Lake				Repulse Bay		% Presence
	9–3	(wet) 9–6	(low site) 9–28	9–29	(dry) 9–54	9–55	(dry) 9–57	(dry) 9–58	(dry) 9–61	9–67	
Alectoria nigricans	x						x		tr		30
Alectoria nitidula	x			x			x	tr	tr	x	60
Alectoria ochroleuca	x	x	x	x		x	x		x	x	80
Asahinea chrysantha							x				10
Caloplaca cinnamomea										x	10
Cetraria andrejevi	x	x	x								30
Cetraria cucullata	x	x	x			x	x	x	x	x	80
Cetraria delisei		x	x								20
Cetraria islandica	x	x			x	x		tr		x	60
Cetraria kamtchatica	x										10
Cetraria laevigata										x	10
Cetraria nivalis	x	x	x	x	x	x	x		x	x	90
Cetraria tilesii									x	x	20
Cladonia alpestris			x	x			x	x			20
Cladonia amaurocraea		x	x		x	x		x			50
Cladonia coccifera			x								10
Cladonia gracilis var. gracilis		x			x			x			30
Cladonia lepidota		x									10
Cladonia mitis	x	x	x		x	x	x				60
Cladonia rangiferina		x	x								20
Cornicularia divergens	x		x	x		x	x		x	x	70
Dactylina arctica	x	x	x							x	40
Dactylina ramulosa			x								10
Hypogymnia subobscura									x		10
Lopadium pezizoideum						x					10
Ochı olechia upsaliensis										x	10
Ochrolechia frigida var. thele.										x	10
Parmelia omphalodes									x	x	20
Peltigera aphthosa	x										10
Peltigera pulverulenta		x	x								20
Pertusaria pangyra						x				x	20
Pertusaria subobducens										x	10
Sphaerophorus fragilis			x								10
Sphaerophorus globosus	x		x	x		x	x				50
Stereocaulon globosus		x									10
Thamnolia subuliformis	x			x	x				x	x	50

TABLE 20. — Lichen species in esker transects — (Snow Bunting Lake)

	Transect number					% Presence
	9–26	9–31	9–32	9–33	9–38	
Alectoria ochroleuca	x	x	x	x		80
Alectoria nigricans			x	x		40
Alectoria nitidula	x					20
Cetraria andrejevii					x	20
Cetraria cucullata	x	x	x	x	x	100
Cetraria islandica		x	x	x	x	80
Cetraria nivalis	x		x	x	x	80
Cladonia alpestris			x			20
Cladonia amaurocraea	x	x	x	x	x	100
Cladonia bellidiflora						20
Cladonia coccifera	x		x		x	60
Cladonia cornuta	x					20
Cladonia gracilis var. chord.				x		20
Cladonia lepidota			x			20
Cladonia mitis	x			x		40
Cladonia rangiferina			x	x	x	60
Cladonia squamosa	x					20
Cladonia uncialis			x			20
Cornicularia aculeata				x		20
Cornicularia divergens	x	x		x	x	80
Dactylina arctica	x				x	40
Dactylina ramulosa					x	20
Lecanora epibryon	x					20
Nephroma expallidum		x			x	40
Ochrolechia frigida f. thelip.					x	20
Ochrolechia frigida	x		x			40
Peltigera aphthosa		x			x	40
Peltigera polydactyla					x	20
Pertussaria coriacea (sp.?)	x					20
Pertussaria panyrga	x					20
Sphaerophorus globosus	x				x	40
Stereocaulon alpinum			x			20
Stereocaulon rivulorum			x	x	x	60
Stereocaulon tomentosum		x	x			40
Thamnolia subuliformis				x		20

TABLE 21. — Lichen species on lag gravel ridge sites — (Pelly Lake and Repulse Bay)

	Transect number and area			
	Pelly Lake		Repulse	
	9–9	9–15	9–65	9–68
Alectoria nigricans			x	
Alectoria nitidula	x	x	x	x
Alectoria ochroleuca	x	x	x	x
Cetraria cucullata			x	
Cetraria hepatizon				x
Cetraria nivalis	x	x		x
Cladonia amaurocarea	x	x	x	
Cladonia coccifera			x	
Cladonia rangiferina	x		x	
Cornicularia divergens	x	x	x	x
Hypogymnia suboscura			x	x
Lecanora epibryon				x
Ochrolechia frigida				x
Ochrolechia upsaliensis			x	
Parmelia omphaloides			x	x
Pertusaria panyrga		x	x	
Rinodina turfacea				x
Sphaerophorus globosus			x	x
Thamnolia subuliformis	x	x	x	x
Thamnolia vermicillaris				x

TABLE 22. — Lichen species in low meadow transects (Repulse Bay)

	9–25	9–59	9–71
Alectoria nigricans			x
Alectoria nitidula			x
Alectoria ochroleuca	x		x
Cetraria cucullata	x		x
Cetraria islandica			x
Cetraria nivalis			x
Cetraria tilesii		x	
Cornicularia aculeata			x
Cornicularia divergens			x
Dactylina arctica		x	
Hypogymnia subobscura			x
Ochrolechia frigida		x	
Parmelia omphalodes			x
Thamnolia subuliformis		x	x
Thamnolia vermicularis			x

TABLE 23. — Lichen species in tussock muskeg/low meadow — Pelly Lake and Repulse Bay

	Transect number		
	Pelly		Repulse No stand
	9–22	9–24	
Alectoria nigricans		x	
Alectoria nitidula	tr*		
Alectoria ochroleuca		x	
Cladonia amaurocraea	tr	x	
Cladonia rangiferina	tr	x	
Cetraria cucullata	x	x	x
Cetraria islandica	tr	x	x
Cetraria nivalis			x
Cornicularia divergens	tr	tr	
Dactylina arctica	x	x	
Parmelia omphalodes			x
Pertussaria panyrga			x
Thamnolia subuliformis			x

General Discussion

The studies conducted in the Northern Keewatin area provide some justification for Drury's statement (Drury 1962) that there "are no special vegetation types that occur on slopes, or on hilltops, or on valley bottoms" in the sense that all species found in the area are very apt to have individual representatives on any or all topographic positions, at least on small, locally favorable sites. Thus, *Eriophorum* appears with greatest frequency on wet lowland areas, but is also found in small wet swales on rock field summits. However, the frequency of sites favorable to *Eriophorum* is lower on rocky uplands than in meadows, and, hence, *Eriophorum* shows a very low frequency in rock field transects, giving way to species adapted to dry windswept uplands. In this sense, there are characteristic aggregations of species on the rock field uplands which can be said to constitute identifiable communities.

It appears there are variations in community structure from place to place associated with climatic differences and probably to differences as well in general topography, surficial geology, altitude, and the characteristic frost features found on landforms (which differ somewhat

from one area to another). Although rigid statistical control of physical landscape and frost action features was impossible in this study, it is apparent that such common and similar features as rock fields, dry slopes, and wet meadows establish suitable bases for environmental comparability from one area to another even though no measure other than gross topographic positioning could be employed in establishing transect sites. The areas, additionally, possess a remarkably uniform geological structure and history. By replication of stands, each taken from a different area often several miles apart, variation within and between stands can be discerned and valid comparisons made.

The higher elevation of the Curtis Lake study area may account somewhat for the apparent similiarity with that described on Bylot Island (Drury 1962) several hundred miles farther north (even though Bylot is at sea level and hence subject to marine climatic amelioration). The species lists are similar and although the general treatment of data is different the similarities in the communities are nevertheless conspicuous.

In the study here, site or topographic characteristics have been simplified to delineation of major landform types occupying a major proportion of the land surface, and 1 m^2 sampling tends not to differentiate associations in terms of terrain micro-features such a "polygon edge" or "polygon center" but to stress the frequency of species on the general landform type. Further work to designate the "micro" associations on smaller terrain features must await the work of others. The major regional differences were those of interest here, not those differences associated with relatively small-scale local environmental variations. These can best be discerned by sampling methods devised to detect finer degrees of community differences and, presumably, to utilize smaller quadrat sizes or perhaps point or line techniques.

The vegetation – specifically composition and structure of the plant communities found on the various topographic locations (sites) – appears on at least most sites to be determined primarily by raw physical forces and secondarily, if at all, by the vegetational history of the site. Succession, hence, is a relatively minor consideration in achieving an understanding of the communities, if it need be considered.

Frost action is the main disturbing force. Following disturbance by frost, the same community that existed on the site before disturbance will tend to recolonize the area, since only minor (but more or less permanent) changes in microtopography result from the frost action. Thus, on a hypothetical flat surface of sand and gravel, occupied by a given number of species within certain frequencies, frost action may initially disrupt or destroy the community, to be folowed by re-invasion of the micro-topographical feature by plants of the original community most suited to this initial invasion and pioneer occupancy. Transect data (from quadrats sufficiently large to obscure pattern) will provide data with a high coefficient of similarity between the community existing before disturbance by frost action and that existing on the site afterward. A study of pattern, however, would reveal a much more marked patterning of species after the frost action than before. In a study such as the one undertaken here, however, pattern is not considered intensively and quadrat size and transect length tend to furnish a generalized description of the vegetation of the major landforms, not those variations that are the consequence of micro-topographic differences.

There remain, indeed, many problems to study, in terms of sampling theory, pattern delineation, and correlation with environmental characteristics. It is hoped that this study will, in at least a few ways, aid in the formulation of further questions to be asked of nature in the Arctic and disclose at least some hints as to how the problems to be formulated might be approached.

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APPENDIX I. Bryophytes present in various communities of study areas.

Pelly Lake. Summit outwash plain — *Dicranum groenlandicum, Sphenolobus minutus, Polytricum piliferum.*

Low meadow — *Aulacomnium turgidum, Calliergon sarmentosum, Cinclidium arcticum, Dicranum laevidens, Drepanocladus badius, D. revolvens, D. uncinatus, Hylocomium alaskanum, Oncophorus wahlenbergii, Polytrichum commune, Ptilidium ciliare, Sphagnum balticum, S. lenense, S. squarrosum, S. subfulvum, S. warnstorfii, Tetraplodon mnioicles.*

Snow Bunting Lake. Esker summit — *Ditrichum flexicaule, Orthothecium chryseum, Pogonatum dentatum, Pohlia nutans, Polytrichum piliferum, Sphenolobus minutus.*

Curtis Lake. Rock field — *Andreaea rupestris, Aulacomnium turgidum, Dicranoweisia crispula, Ditrichum flexicaule, Grimmia apocarpa* var. *stricta, Gymnomitrium coralloides, Ptilidium ciliare, Rhacomitrium canescens, R. lanuginosum, Rhytidium, rugosum, Sphenolobus minutus, Tomenthypnum nitens, Tortella tortuosa.*

Repulse Bay. Rock field — *Bryum* sp., *Didymodon asperifolium, Distichium* sp., *Ditrichum flexicaule, Rhacomitrium lanuginosum, Trichostomum cuspidatissimum.*

Low meadow — *Aulacomnium acuminatum, A. palustre, A. turgidum, Bryum pseudotriquetrum, Catoscopium nigritum, Cinclidium arcticum, Distichium* sp., *Ditrichum flexicaule, Drepanocladus badius, D. revolvens, D. vernicosus, Hypnum hamulosum, Meesia triquetra, Ortholecium chryseum, Polytrichum juniperinum, Ptilidium ciliare, Tomenthypnum nitens, Tortella fragilis, T. tortuosa.*

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Notes

Range Extension of Black Ash, *Fraxinus nigra* Marsh., in Manitoba[1]

Abstract. Range extensions, not previously reported in floras for the Manitoba region, are reported for black ash.

The black ash stand in the Portage la Prairie area appears to be the only stand in the Grassland Forest Region. Black ash in this area is competing successfully with a number of prairie tree and shrub species. This stand should be a promising source of strains adapted to the prairie region. It is the most westerly site reported for this species in North America.

Black ash is a component of the eastern North American forest regions and typically is a tree of swampy woodlands. The range of black ash in Manitoba is given by Scoggan (1957) as eastern Manitoba. The most northwesterly collection cited was Gimli while farther south the most westerly citations were Grand Beach and Whiteshell Forest Reserve. Hosie (1969) listed the general distribution of black ash as occurring south and east of the broken line shown in Figure 1. He further states that "To the west it just reaches the edge of the Grasslands" (Forest Region). The westerly distribution of black ash in the United States extends south and east from Manitoba through Minnesota and Iowa (1949). Three previously unreported locations for black ash, representing documented range extensions have been found.

Specimens of black ash were collected 10 miles east of Portage la Prairie in 1968 and further collections were made in 1970 (Ronald 1355-1357), (1377-1381). The most westerly collection was made about two miles east of Portage la Prairie, the most easterly collection about 25 miles farther east (Figure 1). Most stands were found near the Assiniboine River but collections were also made along the Elm River and La Salle River. In 1970, black ash stands were also discovered in the Birds Hill (Ronald 1371) and Hecla Island (Ronald 1226) areas (Figure 1). The Birds Hill site is about 40 miles south east of locations cited by Scoggan and west of the distribution line given by Hosie. The Hecla Island site is about 25 miles north of the Gimli collection listed by Scoggan but within the general area given by Hosie. These previously unreported sites indicate that an even wider range may exist for this species. Duplicates of all collections have been deposited in the herbaria of the Morden Research Station, Morden; National Museum of Canada, Ottawa; and Plant Research Institute, Ottawa.

[1]Contribution No. 95

Mature reproducing trees and seedlings were found at all three sites. Annual ring counts of 55 and 63 were obtained on two recently felled trees in the Portage la Prairie area. The stands of black ash in the Birds Hill and Hecla Island areas were growing in swampy woodland sites typical for the species. In contrast, the occurrence of black ash stands in the Portage la Prairie area appears significant as this site is far removed from its usual swampy habitat. Because of indicated site differences, a listing was made of tree and shrub associates of black ash in both a Portage la Prairie and a Birds Hill stand. *Quercus macrocarpa* Michx., *Ulmus americana* L. *Fraxinus pennsylvanica* Marsh., *Cornus stolonifera* Michx., *Viburnum trilobum* Marsh., *Rubus idaeus* L. *strigosa* (Michx.) Maxim., *Ribes americanum* Mill., and

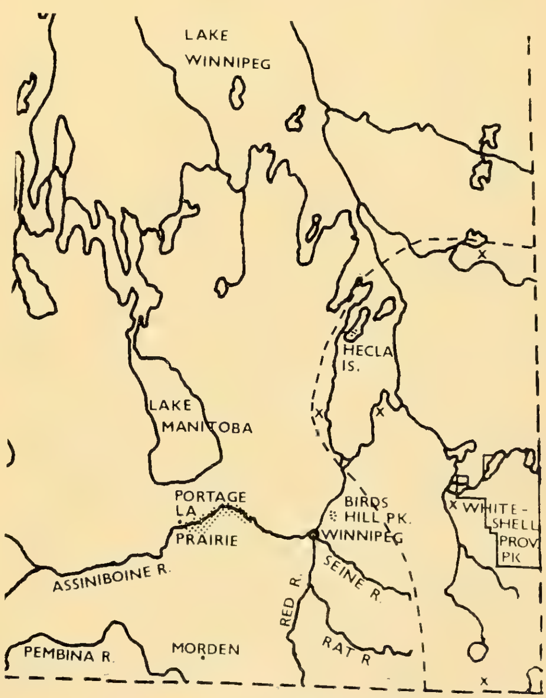

FIGURE 1. Distribution of black ash in Manitoba: the western distribution given by Hosie (Broken line), specific localities listed by Scoggan (X) and three new localities (Dotted).

Prunus virginiana L. were common to both sites. *Thuja occidentalis* L., *Picea glauca* (Moench) Voss., *Betula papyrifera* Marsh., *Populus tremuloides* Michx., *P. balsamifera L.* and *Salix serissima* (Bailey) Fern. were associated with black ash in the Birds Hill site. *Tilia americana* L., *Symphoricarpos occidentalis* Hook., *Corylus americana* Walt., *C. cornuta* Marsh., *Viburnum rafinesquianum* Schultes, *Rosa woodsii* Lindl. and *Parthenocissus inserta* (Kerner) K. Fritsch, were associated with black ash in the Portage la Prairie site. Although a number of species are common to both sites, two predominantly boreal species *Picea glauca* and *Thuja occidentalis* are not native to the Portage la Prairie area. *Tilia americana*, common to the Grasslands Region of Manitoba, was not found in the Birds Hill area. The remaining species differences also indicate the affinity of the Portage la Prairie area to the Grasslands Region in which it was placed by Rowe (1959).

The origin of black ash in the Portage la Prairie area is speculative. This area was subject to glaciation and subsequent flooding from glacial Lake Agassiz which appears to rule out relic stands. This population could be a post glacial extension from existing eastern populations or from a western retreat which has since disappeared.

The fact that black ash is growing and reproducing in the Grasslands region is significant. In a number of Portage la Prairie stands, black ash was the dominant tree competing with *Fraxinus pennsylvanica, Tilia americana* and *Ulmus americana.* This idicates that this species can adapt to drier sites. Up to the present, black ash has been recommended only for moist sites but the present study indicates that some other factor may control its distribution. Studies by the author have shown that black ash has a complex seed dormancy overcome by a moist warm stratification followed by a moist cool stratification (unpublished results). Periodic spring flooding, such as occurs along the Assiniboine River, may help in breaking seed dormancy or in establishment of seedlings. Once established, black ash appears well adapted to the Grassland Region.

These native stands in the Portage la Prairie area represent the most westerly North American site reported for black ash. This site appears to have the most promise as a source of strains adapted throughout the prairie provinces.

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W. G. RONALD

Morden Research Station
Canada Department of Agriculture
Morden, Manitoba

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The White Mullet, *Mugil curema,* Added to and the Striped Mullet, *M. cephalus,* Deleted from the Canadian Atlantic Fish Fauna

The genus *Mugil* has been reported twice for the Atlantic coast of Canada in the inshore waters of Nova Scotia, once by Vladykov in 1935 (and by subsequent authors such as Leim and Scott, 1966, who have repeated his record) and once by Gilhen (1969). The material was identified in both papers as the striped mullet, *Mugil cephalus* Linnaeus. Study of these and additional specimens (excepting Vladykov's which could not be located) showed that all extant material should be identified as the white mullet, *Mugil curema* Valenciennes (Figure 1). This paper extends the known range of *M. curema* northward and provides the first published record for Canada. *M. cephalus* is deleted from the Canadian ichthyofauna.

Two unpublished mullet collections in the ichthyology collection of the National Museum of Natural Sciences, Ottawa, taken from Nova Scotia waters (see Table I), were identified in 1962 by the curator, Dr. Don E. McAllister, as *Mugil curema.* McAllister's identification, confirmed by the present study, was based mainly on anal fin ray counts of III 9, a characteristic of *M. curema.* The anal fin ray count for *M. cephalus* is III 8.

The author examined 30 samples of preserved juvenile mullets (27 samples in the Nova Scotia

TABLE 1. — Collections of the White Mullet, *Mugil curema* from inshore Nova Scotia waters.

Location of specimens	Catalogue No.	Date Collected	Locality (General)	No. of specimens
National Museum of Natural Sciences, Ottawa	NMC62–52	September 17, 1917	Jeddore Harbour, Halifax County	1
Place of deposit unknown	–	September 29, 1931	Bedford Basin, Halifax County	1
National Museum of Natural Sciences, Ottawa	NMC62–64	September 14, 1961	Chester Basin Lunenburg County	3
Nova Scotia Museum Halifax	966–Z–4–1(2)	September 1, 1966	Prospect Bay, Halifax County	2
St. Mary's University, Halifax	407–1(4)	September 1, 1966	Prospect Bay, Halifax County	4
Nova Scotia Museum, Halifax	966–Z–12–1(4)	September 6, 1966	Prospect Bay, Halifax County	2
Royal Ontario Museum, Toronto (out of the preceding collection)	25177	September 6, 1966	Prospect Bay, Halifax County	2
Nova Scotia Museum, Halifax	966–Z–5–1(57)	September 10, 1966	Prospect Bay, Halifax County	57
St. Mary's University, Halifax	407–2(49)	September 10, 1966	Prospect Bay, Halifax County	49
Nova Scotia Museum, Halifax	968–Z–61–1(7)	September 24, 1968	Prospect Bay, Halifax County	7
Nova Scotia Museum, Halifax	968–Z–61–2(11)	September 29, 1968	Prospect Bay, Halifax County	11
Nova Scotia Museum, Halifax	968–Z–61–3(2)	October 1, 1968	Prospect Bay, Halifax County	2
Nova Scotia Museum, Halifax	968–Z–61–4(16)	October 8, 1968	Prospect Bay, Halifax County	16
Nova Scotia Museum, Halifax	968–Z–61–5(10)	October 12, 1968	Prospect Bay, Halifax County	10
Nova Scotia Museum, Halifax	968–Z–61–6(2)	October 17, 1968	Prospect Bay, Halifax County	2
Nova Scotia Museum, Halifax	968–Z–61–7(14)	October 22, 1968	Prospect Bay, Halifax County	14
Nova Scotia Museum, Halifax	968–Z–61–8(14)	October 28, 1968	Prospect Bay, Halifax County	14
Nova Scotia Museum, Halifax	968–Z–61–9(1)	October 29, 1968	Prospect Bay, Halifax County	1
Nova Scotia Museum, Halifax	968–Z–7–1(2)	August 24, 1969	Prospect Bay, Halifax County	2
Nova Scotia Museum, Halifax	968–Z–17–1(11)	September 4, 1969	Prospect Bay, Halifax County	11
Nova Scotia Museum, Halifax	968–Z–18–2(2)	September 10, 1969	Prospect Bay, Halifax County	2
Nova Scotia Museum, Halifax	968–Z–24–1(8)	September 10, 1969	Prospect Bay, Halifax County	8
Nova Scotia Museum, Halifax	968–Z–19–1(10)	September 16, 1969	Prospect Bay, Halifax County	10
Nova Scotia Museum, Halifax	968–Z–20–1(13)	September 22, 1969	Prospect Bay, Halifax County	13
Nova Scotia Museum, Halifax	969–Z–21–1(16)	September 30, 1969	Prospect Bay, Halifax County	16
Nova Scotia Museum, Halifax	969–Z–22–1(15)	October 6, 1969	Prospect Bay, Halifax County	15
Nova Scotia Museum, Halifax	970–Z–158–1(10)	August 10, 1970	Prospect Bay, Halifax County	8
Nova Scotia Museum, Halifax	970–Z–166–1(8)	August 14, 1970	Prospect Bay, Halifax County	8
Nova Scotia Museum, Halifax	970–Z–184–1(5)	September 16, 1970	Prospect Bay, Halifax County	5
Nova Scotia Museum, Halifax	970–Z–193–1(1)	September 23, 1970	Prospect Bay, Halifax County	1
Nova Scotia Museum, Halifax	970–Z–186–1(8)	September 17, 1970	Prospect Bay, Halifax County	8
Nova Scotia Museum, Halifax	970–Z–199–1(5)	October 8, 1970	Prospect Bay, Halifax County	5
Nova Scotia Museum, Halifax	970–Z–405–1(2)	October 14, 1970	Prospect Bay, Halifax County	2

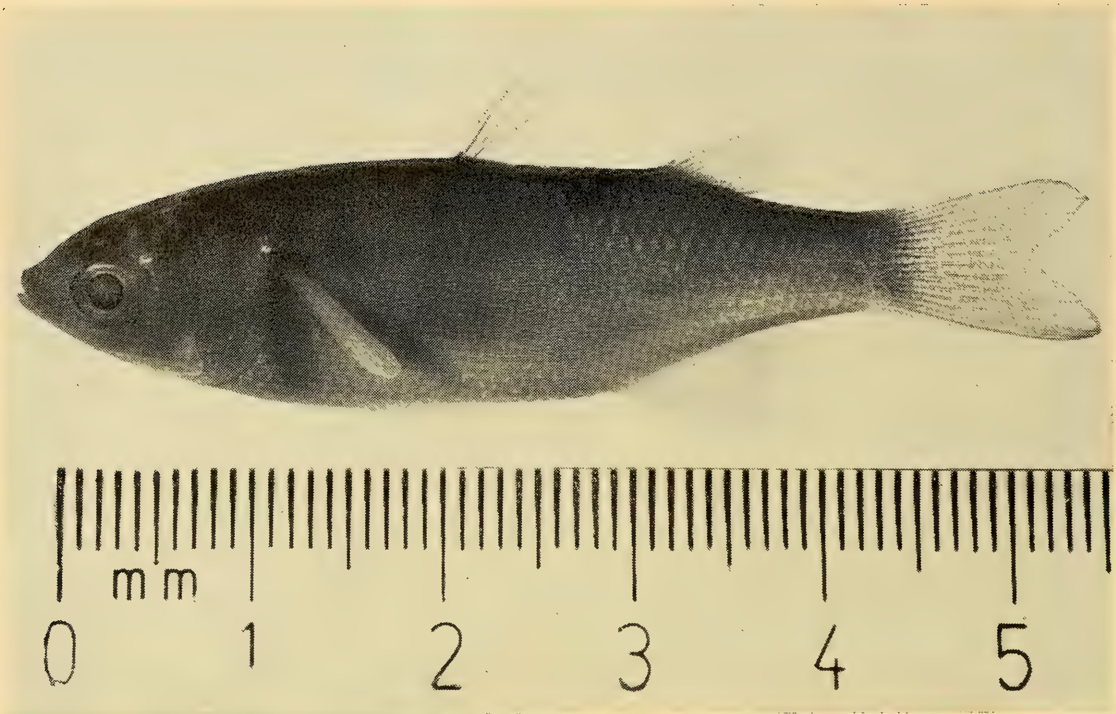

FIGURE 1. Juvenile White Mullet, *Mugil curema* from Prospect Bay, Halifax County, Nova Scotia.

Museum Fish Collection, two in St. Mary's University, and one in the Royal Ontario Museum) taken from Prospect Bay, Halifax County, and found the anal fin ray count also to be III 9. A total of six specimens from two of the Prospect samples (catalogue numbers 968-Z-61-7(14) and 970-Z-199-1(15) were sent to the Marine Research Laboratory, State of Florida Department of Natural Resources, where Kenneth R. Halscott confirmed the identification of the Nova Scotia Museum specimens as *M. curema.* Halscott's identification was based primarily on anal fin ray and body scale counts, plus characteristics documented by Anderson (1957 a and b).

A mullet 77 millimeters in total length, determined as *M. cephalus,* taken in Bedford Basin, Halifax County, in 1931 (Vladykov, 1935) is missing. However, the author believes that this specimen may also have been misidentified. All 311 specimens from the 32 extant collections of *Mugil* from Nova Scotia examined in this study have been *M. curema.* Vladykov's record is probably a misidentification and is tentatively tabled as the second collection of *M. curema* from inshore Nova Scotia waters. *M. cephalus* is deleted from the Canadian ichthyofauna until a verifiable specimen is found. Bigelow and Schroeder (1953) report only *M. cephalus* from the adjacent waters of the Gulf of Maine; the possibility of their records being *M. curema* should be examined.

All Canadian records to date of *M. curema* are juveniles ranging from 28.5 to 77 millimeters in total length and were taken in inshore Nova Scotia waters, between Halifax and Lunenburg Counties.

The author gratefully acknowledges the advice and encouragement received from Dr. Don E. McAllister, Curator of Fishes, National Museum of Natural Sciences, Ottawa, during the course of this investigation and to Kenneth R. Halscott, Marine Research Laboratory, State of Florida Department of Natural Resources for identification services and a gift of juvenile *M. cephalus* and *M. curema.* Thanks are also expressed to Dr. Alfonso Rojo, Associate Professor of Ichthyology, St. Mary's University, Halifax, Dr. W. B. Scott, Curator of Ichthyology, Royal Ontario Museum, Toronto, for the loan of specimens, and Dr. Vic-

tor G. Springer, Division of Fishes, U.S. National Museum, Washington. The photograph (Figure I) was taken by Ronald Merrick of the Nova Scotia Museum.

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JOHN GILHEN

Nova Scotia Museum,
Halifax, Nova Scotia
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Notes on Home Range and Social Behavior in Adult Richardson's Ground Squirrels (*Spermophilus richardsonii*)

Abstract. The home range, movements, and aspects of the social behavior of adult *Spermophilus richardsonii* were observed during the summer of 1967 at Riding Mountain National Park, Manitoba. The amount of daily activity increased toward early June and became shorter toward mid July as hibernation approached. Daily activity was bimodal during June, with the least activity at noon. Home burrows tended to be acentric in the home ranges. Boundries of home ranges were not clearly delineated. Squirrels tend to remain near the center of the home range in the first part of May, wander farther afield until mid June, and then spend more time in their home range centers as hibernation approaches. Squirrels initiating agonistic behavior did so from points in their home ranges highly frequented by them, whereas squirrels that were chased were in areas seldom frequented by them.

Field observations on a colony of Richardson's ground squirrels, *Spermophilus richardsonii richardsonii,* were made in 1967 during 5-29 May, 8 June-3 August, and 22 August-1 September. The study area was located in a forest clearing in the Baldy Lake Warden District, Riding Mountain National Park, Manitoba. A description of the area appeared elsewhere (Michener, 1969). Squirrels were trapped by setting National Live traps around the entrances to the most frequently used burrows. They were sexed and fitted with numbered steel ear tags, one in each ear, for permanent identification. Each squirrel was given a unique mark with Nyanzol A black fur dye (Nyanza Inc.) so that any individual could be identified from a distance. Dye marks were replaced when they faded or were lost during molting. The area was divided into a 100 foot grid, and field records of the locations and activities of the ground squirrels were kept from the time that they emerged from their burrows in the morning until they retired.

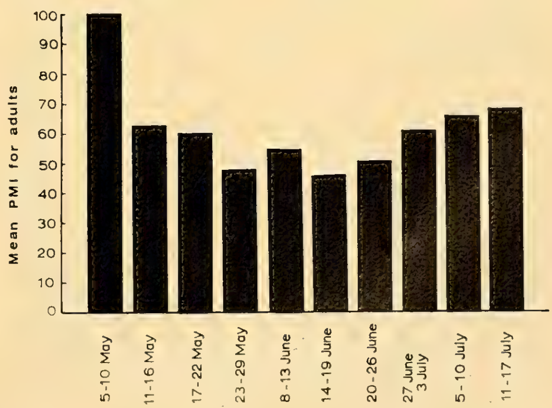

FIGURE 1. Home range usage expressed as the average PMI of grid sections visited by adult *S. richardsonii* on the study area.

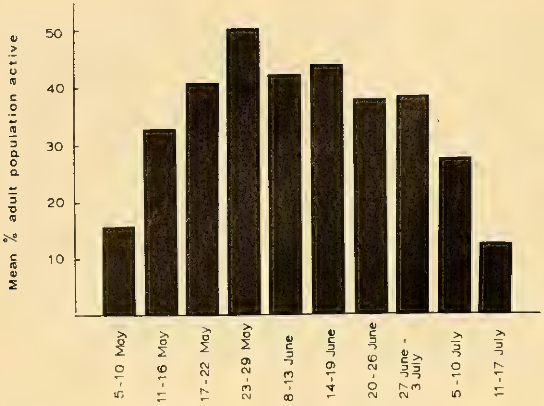

FIGURE 2. Average percentage of adult *S. richardsonii* active during the day.

Observations were made with 8 x 30 binoculars and a spotting telescope, and a census of the area was taken every 30 minutes.

The total population of the area consisted of seven adults, all females, when observations began. An adult male and an adult female were introduced to the colony on 6 June, and another adult male and two adult females were introduced on 4 July.

The duration of daily activity increased until early June, and then became shorter as hibernation approached. During June the activity pattern was bimodal and similar to that described in *Spermophilus tridecemlineatus,* (McCarley, 1966), *Spermophilus beecheyi* (Fitch, 1948), *Spermophilus undulatus* (Mayer, 1953), *Ammospermophilus* (Hawbecker, 1953, 1958), and *Marmota flaviventris* (Armitage, 1962).

Home ranges were determined by plotting the positions of each animal on maps of the study area. Some parts of each squirrel's home range were used more frequently than others. A 50 foot grid was placed over the range maps and the number of times each animal was observed in each square recorded. To compare the individuals the grid section with the highest score was designated as 100% and all grid sections in which that animal was seen were given percentages expressed as a percentage of that maximum, the percentage of maximum incidence or PMI.

The areas of 100% PMI (where the home burrow was located) of seven of the adults on the area in May and June were acentric in their home ranges. As a consequence, the frequency of occurance of a squirrel did not decrease equally in all directions from the home burrow. Two squirrels had two areas of high PMI separated by an area of low incidence. The home range boundries were not clearly delineated. Areas frequently used graded into areas less frequently used that may have constituted buffer areas between adjacent squirrels and did not appear to be part of either's territory, as agonostic behavior was rarely initiated there. The shape of a home range did not appear to be governed by vegetation or by ranges of other squirrels.

The size of home ranges changed during the season. Most adults stayed within the area of 100% PMI during the first part of May, gradually wandered farther afield until mid June, then spent more time near their center of activity as hibernation approached in July (Figure 1). The average percentage of the population active at any one time was least in early May, highest in late May and June, and again low in mid July (Figure 2). Activity, both in terms of area of home range and in numbers of active squirrels, was greatest from late May to early June.

Forty-seven chases were observed. These occurred throughout the daily activity period and varied in distance from 6 to 200 feet, the average distance being 64.6 feet. Most chases occurred in May and the first 3 weeks of June. A squirrel initiating a chase did so from an area of high PMI. The average PMI from which a squirrel started a chase was 50.8%, whereas that for the squirrel chased was 19.3%. At the end of the chase the chaser had reached an area of 25.8% average PMI, whereas the chased squirrel had moved to one of 30.0%. Thus, an area known by a squirrel is defended against an intruder less familiar with the area. This agrees with conventional views of territoriality.

Forty-three per cent of the chases observed ended in fighting, with the squirrels rolling together and squealing loudly. The only male on the area before 4 July was the object of 49% of all the chases and was never seen to chase another squirrel. Chases involving the male averaged 105 feet, whereas chases involving only females averaged 40 feet. Although the home range of the male was not larger than the average home range of a female, the area of low PMI was proportionately greater. Consequently, the male was usually in an area of lower PMI than the aggressive fe-

male. Work by G. Michener (personal communication) and Yeaton (1969) indicates that adult males do not defend territories after the breeding season and are subsequently subordinate to all females.

Encounters were frequently avoided by squirrels in low PMI areas of their home ranges. When a dominant squirrel saw a subordinate, often from a distance of 50 to 100 feet, it would run in a direct line toward the subordinate. If the subordinate squirrel was aware of the aggressor, it would run toward a more central portion of its home range. When an aggressive squirrel arrived in an area where the subordinate had been, it would look in all directions and then resume eating. Tooth chattering by the subordinate frequently followed such an encounter.

At times two or three squirrels fed together within a few feet, ignoring each other. This behavior was common with certain pairs, usually those that had proximal home burrows (within 40-50 feet of one another). Exceptional behavior was seen in two adult females, who used the same burrow and had similar home ranges much of the summer.

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DANIEL R. MICHENER

Department of Biology
University of Saskatchewan Regina Campus
Regina, Saskatchewan
Received March 21, 1971
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Response of Pintails to Improved Breeding Habitat in Southern Manitoba

Abstract. Migrant Pintails responded to ideal nesting habitat in 1969 at St. Andrews Bog north of Winnipeg, Manitoba, by remaining to nest in unusually large numbers. Success of the initial nesting attempt and subsequent brood survival were excellent. Key factors in the phenomenon were the reservoir of migrant Pintails; the large acreage of new nesting habitat; favourable weather starting in early April with no subsequent setbacks; virtual absence of nest losses; and sufficient rainfall through mid-July to maintain brood habitat. The elastic response of Pintails to their surroundings suggests that *extensive* programs of environmental protection across the species' vast breeding range must be considered in their future management.

This note records observations on the response of breeding Pintails (*Anas acuta*) to improved habitat in 1969 in southern Manitoba. Although the phenomenon was widespread, our field data apply only to a semi-permanent marsh, known as St. Andrews Bog, 20 miles north of Winnipeg, Manitoba.

Hochbaum (1946) recognized that Pintails will readily pioneer into nesting habitat to which they have no natal attachment. He wrote: ". . . when new water areas are created there is a response on the part of certain ducks which come to nest at these new places . . . It was shown by the 1945 behavior of river ducks on Manitoba farmland. These birds, in their many thousands, bred on new waters which had not existed within their individual life spans. In other words, these ducks moved to areas with which they could have had no previous experience and which had not been used by ducks for at least one waterfowl generation."

TABLE 1. — Duck broods observed in St. Andrews Bog, June 12 and 14, and July 10 to 12, 1969.

Species	June Survey Nos.	Percent of Total	July Survey Nos.	Percent of Total	Total Both Surveys	Percent of Total Both Surveys
Pintail (*Anas acuta*)	68	73.12	99	72.26	167	72.61
Shoveler (*Spatula clypeata*)	7	7.53	18	13.14	25	10.87
Mallard (*Anas platyrhynchos*)	11	11.82	11	8.03	22	9.56
Green-winged Teal (*Anas carolinensis*)	2	2.16	1	.73	3	1.30
Blue-winged Teal (*Anas discors*)	0	0.0	5	3.65	5	2.18
Baldpate (*Mareca americana*)	1	1.07	1	.73	2	.87
Redhead (*Aythya americana*)	4	4.30	2	1.46	6	2.61
Totals	93	100.00	137	100.00	230	100.00

Northward movement of breeding pintails during prairie droughts has been discussed by Smith (1970). In summary, he wrote: ". . . northern areas contain a reservoir of pintails which supplies the prairies with breeding populations when conditions there are favourable."

St. Andrews Bog is a treeless, flat, wet-meadow of several thousand acres where agricultural encroachment, aided by artificial drainage, has met with only partial success. Grain fields, mainly sown to barley, wheat, and oats, ring the central portion which is peaty and is used for pasture and hayland. Imperfect drainage limits agricultural use. Almost every spring several thousand acres, including some of the peripheral grainland, are flooded. Flooding occurs occasionally during other seasons and contributes to the area's low agricultural capability. The area is risky also for breeding waterfowl; there are only about 150 acres of permanent marsh in the basin of the Bog, and agricultural activities, mainly spring burning and tillage, usually create hazardous nesting conditions by mid-May.

Migratory waterfowl, notably Canada Geese (*Branta canadensis*) and Pintails, make heavy use of the Bog as a spring staging area prior to departure for breeding grounds. The Canada Geese are known from banding data to be birds that winter mainly in Missouri and nest on the Hudson Bay Lowlands of northern Manitoba. The Pintails also are thought to be from a northern-oriented population. The staging period lasts from early April to early May. At times over the past several years such gatherings of paired Pintails have numbered up to 20,000 individuals.

The stage for the St. Andrews Bog phenomenon was set in the fall, winter, and spring of 1968/69. Wet autumn weather saturated the ground and delayed harvest of grain. Cultivation of stubble, which is carried out if possible prior to freezeup, was minimal. Thus, grain stubble, a favourite nesting site of Pintails, was abundant in the periphery of the Bog in the spring of 1969.

Winter snowfall was heavy, and thaw set in abruptly on April 5. Temperatures remained unusually mild and within a week the Bog was virtually snow-free and under several inches of water. Shallow flooding was held into early July by above normal rainfall, which also delayed agricultural burning and tillage until late in the summer.

Large numbers of Pintails, presumably many of which would have departed for the north in most years, responded to the ideal conditions by remaining to nest in the Bog. First Pintail clutches were started by April 15, early nests were hatched in mid-May and young were flying by the end of June. Nest predation, which is so common across southern Manitoba, was virtually absent in the Bog. The strong, early, Pintail nesting effort experienced a highly successful termination.

Brood surveys were conducted by walking randomly through the flooded meadows of the Bog on June 12 and 14, and again on July 10, 11, and 12. The June survey was 13 miles long and yielded 93 broods, 73 per cent Pintails. The July survey covered 10 miles and yielded 137 broods, 72 per cent Pintails (Table I). Allowing for a brood-hen flushing distance of 175 feet on both sides of the observer, which seemed reasonable at the time, about 2/3 of a square mile would have been censused on a 10-mile survey. Assuming all broods were recorded on the July survey, the data indi-

cate a Pintail brood per 4.3 acres, or 149 per square mile, or 981 on the 4,200 acres of Bog. The true figure was thought to be some 30 to 40 per cent higher since large numbers of young Pintails had left the Bog habitat by the time of the July survey and were flocked on nearby ditches.

The events at St. Andrews Bog in 1969 are significant in that they exemplify the kind of breeding habitat that short-stops migrating Pintails and the environmental factors that attend successful Pintail breeding attempts. The fact that the conditions that prevailed were so productive of Pintails reveals a great deal about what man might aim for in trying to maintain and develop Pintail breeding habitat. Key factors in the phenomenon were the reservoir of migrant Pintails; the large acreage of new nesting habitat, including grain stubble; favourable weather starting in early April with no subsequent setbacks; virtual absence of nest disturbance from predators and agricultural activities; and sufficient rainfall through mid-July for retention of brood habitat.

Can man ever hope to maintain Pintail numbers through environmental manipulation on the breeding grounds? We hear a great deal about pothole preservation, marsh development and predator control on the prairies and sometimes believe that these measures will be the salvation of *all* duck species. If properly used these practices should be beneficial to Pintails, but it is inconceivable that *intensive* management alone will make a meaningful impact on Pintail numbers.

The elastic response of Pintails to their surroundings suggests to us that *extensive* programs of environmental protection across the species' vast breeding range must be considered in their management. Survival of Pintails in today's numbers will require, in addition to intelligent harvesting, wise policies and practices regarding agricultural land use, water management, and hinterland development. Mankind's survival too may be linked to similar programs of environmental protection.

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George S. Hochbaum
Eugene F. Bossenmaier

Manitoba Department of Mines,
Resources, and Environmental Management,
Winnipeg, Manitoba
Received April 3, 1971
Accepted October 20, 1971

Insects Collected from the Toadflax, *Comandra umbellata* ssp. *pallida* (Santalaceae), Infected by the Rust, *Cronartium comandrae*, in Southern Alberta

Abstract. Sixteen species of insects were collected from bastard-toadflax, *Comandra umbellata* (L.) Nutt. ssp. *pallida (A.DC)* Piehl, infected by *Cronartium comandrae Pk.* in southern Alberta. Two of these, *Mycodiplosis* sp. (Diptera, Cecidomyiidae) and *Bradysia* sp. (Diptera, Sciaridae), had been found associated with the other states of the rust on pine. Larvae of *Mycodiplosis* sp. were most common and fed extensively on the spores of the rust. *Synopeas* sp. (Hymenoptera, Platygasteridae) is probably a parasite of *Mycodiplosis* sp. Two others, *Tetrastichus* sp. (Hymenoptera, Eulophidae) and *Torymus* sp. (Hymenoptera, Torymidae) produced apical galls on *Comandra* plants but had no relationship to the rust. Most of the other species collected were polyphagous feeders or chance visitors on *Comandra*.

From 1964 to 1970, collections were made of the arthropod fauna associated with the spermogonial and aecial states of the comandra blister rust, *Cronartium comandrae* Pk., on lodgepole pine, *Pinus contorta* Dougl. var. *latifolia* Engelm., in Alberta (Powell, 1971a). Arthropods associated with the uredial and telial states of *C. comandrae* on bastard-toadflax, *Comandra umbellata* (L.) Nutt. ssp. *pallida* (A.DC) Piehl, were also collected to determine whether any species was associated with all states of the rust.

Between August 17 and 25, 1965, several hundred dipterous larvae were found feeding on the urediospores and telia of the rust at five locations between Gull Lake and Magrath, Alberta. In

TABLE 1. — Insects collected from *Comandra umbellata* ssp. *pallida* infected by *Cronartium comandrae* in southern Alberta.

HEMIPTERA	
Alydidae	
	Alydus curinus Say.
Miridae	
	Lopidea sp.
HOMOPTERA	
Aphididae	
	Acyrthosiphon pisum (Harris)
	Dactynotus sp.
	? *Metopolophium* sp.
Cicadellidae	
	Cuerna striata Walk.
COLEOPTERA	
Coccinellidae	
	Coccinella sp. imm. poss. *novemnotata* Hbst. or *transversoguttata* Fald.
DIPTERA	
Sciaridae	
	Bradysia sp.
Cecidomyiidae	
	Mycodiplosis sp.*
Chloropidae	
	Oscinella sp.
HYMENOPTERA	
Ichneumonidae	
	Diplazon tetragonus Thunberg
Eulophidae	
	Tetrastichus sp.*
	Chrysocharis sp.
Torymidae	
	Torymus sp.
Platygasteridae	
	Synopeas n. sp.
Formicidae	
	Leptothorax (*Mychothorax*) *canadensis* Provancher

*Also collected from Wasa, British Columbia.

1966, collecting was restricted to two *C. comandrae*-infected stands of *C. umbellata* ssp. *pallida* at the Kananaskis Forest Experiment Station, near Seebe, Alberta, and was limited to the period August 9 to 28. A series of small, wooden-framed, plastic screening cages were placed over infected *Comandra* plants to trap emerging adults. Other insects observed feeding on or among the urediospores and telia on non-caged plants were collected by hand. In 1964, 1967, and 1968, isolated collections were made at scattered locations in southern Alberta, and at a single location in southeastern British Columbia.

A total of 16 species of insects, representing four orders and 13 families were collected from *C. umbellata* ssp. *pallida* infected by the rust (Table 1). Only two of the species, the cecidomyiid *Mycodiplosis* sp. and the sciarid *Bradysia* sp., were found also associated with the rust on pine (Powell, 1971a). The larvae of *Mycodiplosis* sp. were found in most infected stands of *Comandra,* and were observed feeding on the urediospores and telial columns. The dipterous larvae collected in 1965 from 5 locations and those collected in other years at widely scattered points all belonged to this genus. On August 15, 1966, five 1-meter-square plots within rust-infected stands of *Comandra* at one of the Kananaskis locations were checked for the presence of *Mycodiplosis* larvae feeding on the rust. Ninety-nine (38%) of the 261 plants on these plots were infested, and on one plot with 54 plants, 61% of the plants were infested. As many as 20 larvae were counted on a single plant, and as many as five larvae on a single leaf. Most larvae occurred on the underside of the leaf where spore states of the rust were generally more abundant. They occurred also on the stem and fruit when these portions were rust-infected. *Mycodiplosis* spp. have also been found feeding on the spores of other rusts in Alberta (Berkenkamp, 1969; Powell, 1971b). The specimens of *Bradysia* sp. were reared from infected *Comandra,* but were not observed feeding on the rust. The other dipterous species — *Oscinella* sp., was collected when visiting the rust on *Comandra.*

The Hemiptera and Homoptera collected are polyphagous species and probably occur only incidentally on *Comandra. Lopidea* sp. was a common feeder on *Comandra.* The aphids *Acrythosiphon pisum* and *Dactynotus* are usually found on legume and composite plants respectively. The *Coccinella* (Coleoptera) larvae are likely predators of the aphids.

The Hymenoptera were all reared from caged *Comandra* or dissected from dried plants. *Tetrastichus* sp. inhabits a loose apical bud gall. One or more larvae occurred in the axis of each leaf of the bud with usually 6 to 10 larvae per bud. The larvae later entered the leaf and pupated near the center. The adults emerged from the leaves through exit holes in the deformed buds. The one specimen of *Torymus* collected in the study was also obtained from a somewhat different type of terminal bud gall. It is unlikely that these two chalcids have any association with the rust, for they formed galls also on non-infected *Comandra* plants. The genus *Torymus* is a common gall maker (Muesbeck *et al.* 1951). The undescribed *Synopeas* sp. is probably a parasite of *Mycodiplo-*

sis sp. L. Masner (personal communication 1970) indicated that *Synopeas* spp. are primary parasites of Cecidomyiidae.

A number of green lepidopterous larvae were also observed on rust-infected *Comandra* plants but were not identified and are not included in Table 1. The species listed in Table 1 were collected only from infected plants. Other insects, notably various phytophagous Hemiptera, leaf miners and other lepidopterous larvae, were observed on non-infected plants. Piehl (1965) reported lepidopteran leaf miners of the family Agromyzidae, three species from other lepidopteran families, a scale insect, unidentified larvae causing terminal cone-like galls, aphids, two cecidomyiids, and nematodes on *Comandra*. He also gave a list of 61 recorded visitors to the flowers of *C. umbellata* ssp. *umbellata*, largely Diptera and Hymenoptera. Of those mentioned by Piehl, only a *Leptothorax* sp. was commonly found during the present study, although his unnamed cecidomyiids, aphids, and gall-causing organism may be among those listed here.

Acknowledgements

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JOHN M. POWELL

Department of the Environment
Northern Forest Research Centre
Edmonton, Alberta
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First Record of the Cattle Egret in the Northwest Territories.

The Cattle Egret *(Bubulcus ibis)* is widely distributed in southern and central Europe and Africa where it associates with grazing cattle and big game (Binsbergen en Mooij, 1967). The species became established in the New World between 1877 and 1882 and was first collected in North America in 1952 (Godfrey, 1966). There is some indication that the Cattle Egret occurred in the Florida Everglades in the 1940's but was not recognized due to its similarity to other herons (G. Smart, pers. comm.). Canadian records only number in the dozens including observations as far west as Brandon on May 27, 1961 and breeding was first reported from Ontario in 1962 (Godfrey, 1966). Salt and Wilk (1966) refer to the Cattle Egret as an inveterate wanderer and list the only previous record for western Canada, that of a bird captured alive on November 12, 1964 near Iron Springs in southern Alberta. In view of the rarity of the Cattle Egret in Canada and to provide information on its wanderings, the observation of a Cattle Egret on May 26, 1971 at Fort Smith, Northwest Territories, is of interest.

On May 26, Mr. F. Gibot a resident of Fort Smith informed me that during the morning he had seen a white bird feeding near some horses along the main highway at Fort Smith. He described the bird as about the size of a gull but with a long neck and long legs. I advised him I would pick him up so he could show me the location of the bird. Enroute to Mr. Gibot's place of work I drove down the highway and found the bird without difficulty. I observed the bird through binoculars and noted its rather long neck and

yellow bill, white body (size of a Mew Gull) and fairly long yellow-green legs. The bird was feeding near some horses and at one time was seen to fly a short distance. Its flight resembled that of a heron and I at first thought the bird to be an albino medium-sized heron. The bird was feeding in an old meadow now heavily invaded by young aspen, balsam poplar, and willows.

I succeeded in taking about 20 photographs of the bird and on closer examination a light brown mark on the breast, light brown crest, and black feet were noted. I then consulted the Peterson's field guide and concluded the bird was a Cattle Egret. It was decided to collect the bird but the egret just then was being harassed by a female Goshawk and flew off. An hour later I found that the bird had returned and now was resting on a fence post. It then flew to the top of a thirty-foot aspen and I was able to collect the bird. The following measurements were taken: wing 246 mm, tarsus 86 mm, tail 90 mm, culmen 58 mm, weight 393 gr. The bird was a male and the testes measured 10 x 6 mm. Its stomach contained several hundred blowflies and innumerable fly eggs, two spiders, several elytra of beetles, and a partly digested woodfrog *(Rana sylvatica)*. The proventriculus and stomach contained a large number of small pink nematodes. These were identified by Dr. G. G. Gibson, Canadian Wildlife Service as belonging to the genus *Microtetrameres*. In the absence of female specimens the identification as to species could not be made.

The Cattle Egret has been donated to the National Museum of Natural Sciences.

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E. KUYT

Wildlife Biologist,
Canadian Wildlife Service.
Fort Smith, N.W.T.
Received June, 1971
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Common Grackle at Rankin Inlet, Keewatin District

On June 10, 1970, I observed a Common Grackle (*Quiscalus quiscula*) at Rankin Inlet in the Keewatin District of the Northwest Territories. It flew from an unknown point to the top of a communications tower about fifty feet high, where it remained for as long as I continued to watch it, about twenty minutes. Along with Professor J. G. McConnell, who is also familiar with the species, I observed it through 7 x 50 binoculars and noted the white eye and the heavier bill and longer tail than other similar icterids with which it might be confused.

According to W. E. Godfrey (*The Birds of Canada*, p. 360, and personal correspondence), there is no previous record of this species for Keewatin District, the nearest being at Churchill, Manitoba, 300 air miles to the south.

FREDERICK M. HELLEINER

Department of Geography
Trent University
Peterborough, Ontario
Received September 11, 1970
Accepted June 3, 1971

House Sparrow at Schefferville, Quebec

On March 10, 1970, I made a casual observation of two House Sparrows (*Passer domesticus*) at Schefferville, Quebec. Because I was unaware of their status at the time of the observation, I took no care to observe distinguishing features or to note their sex. In fact, there may have been more than two individuals present. Despite these defects, I consider the record to be a valid one because I am thoroughly familiar with the species from other parts of Canada, and the birds were chirping noisily in their accustomed fashion as they huddled around the eaves of a residence.

A search of the literature in the Arctic Institute of North America, and correspondence with Mr. Henri Ouellet of the National Museum of Natural Sciences revealed no published records of this species closer to Schefferville than the north shore

of the Gulf of St. Lawrence, about 360 miles to the south. Thus, the present observations mark a significant range extension into the interior of Labrador-Ungava. It seems probable that the birds reached Schefferville by way of the Quebec North Shore and Labrador Railway from Sept-Iles, Quebec where the species occurs in abundance. In fact, as they are largely non-migratory in North America it is possible that they were accidentally transported on the railway rather than flying to Schefferville on their own.

FREDERICK M. HELLEINER

Department of Geography
Trent University
Peterborough, Ontario
Received September 11, 1970
Accepted June 3, 1971

Lincoln's Sparrow at Inuvik, N.W.T. and Common Starling at Whitehorse, Yukon

The purpose of this note is to report the extension of the known ranges of the Lincoln's Sparrow, *Melospiza lincolnii,* and the Common Starling, *Sturnus vulgaris.* Since the range of the Lincoln's Sparrow extends to central Yukon, the central-western and southeastern areas of the District of MacKenzie, these writers were quite surprised to find a singing bird of this species at Inuvik, N.W.T. on June 10, 1971. Only one bird was found. It was studied, while it was singing on territory, through a 20X Bushnell telescope and the song recorded on tape. The location was near the sewage lagoon along the road leading to the site of the MacKenzie Valley Pipe Line Research experiments. The habitat was a wet area covered by low willows and alder. Owing to insuffcient time, a search for a nest was not made.

A presumed nesting record of the Common Starling was obtained at the airport in Whitehorse, Yukon, on June 12, 1971. We saw two adults repeatedly enter and leave the same hole in the north end wall of hanger B. A total of six adult starlings was seen at the airport. It is of interest that Mrs. Gladys Bruce of Whitehorse told us she believed that this species nested for the first time in Whitehorse in 1970.

M. H. EDWARDS[1]

R. D. WEIR[2]

[1]Department of Physics
[2]Department of Chemistry and Chemical Engineering
Royal Military College
Kingston, Ontario
Received September 16, 1971
Accepted November 15, 1971

Two Unrecorded Nesting Species on Grand Manan Island.

While rearranging the egg collection at the Academy of Natural Sciences I found a set of eggs of the Common Loon *(Gavia immer)* and one of the Arctic Tern *(Sterna paradisaea)* from Grand Manan Island. Pettingill (Proceedings of the Nova Scotia Institute of Science 1937-1938 vol. XIX Part IV) was unaware of these sets.

The data from the tags on the eggs and the comments from the Pettingill paper follows:

Gavia immer, a set of two eggs taken July 10, 1894 on Grand Manan Island, N.B., by R. T. Young. Pettingill comments, "The assertion by Herrick that the Common Loon does not breed on Grand Manan is undoubtedly true, there being no ponds sufficiently large for nesting habitats. Joy, however, noted one at intervals from April to October 1901 on Big Pond near Seal Cove though he found no evidence to indicate its breeding."

Sterna paradisaea, a set of two eggs taken June 23, 1880 on the Island of Grand Manan by J. F. Porter. Pettingill records Arctic Terns breeding on Machias Seal Island, and believed that they must have nested elsewhere on the archipelago notably on White Horse, Three Islands and Western Green Island. He does not mention Grand Manan Island.

C. CHANDLER ROSS

Academy of Natural Sciences
19th and the Parkway
Philadelphia, Pa. 19103
Received June 10, 1971
Accepted August 10, 1971.

Ring-billed Gulls Robbing Lesser Scaup of Food

There are numerous reports of gulls (Laridae) robbing other species of food. More specifically, the Ring-billed Gull *Larus delewarensis* is well known for its opportunistic feeding habits (Vermeer, Can. Wildl. Serv. Rep. Ser. No. 12, undated), and Bent (1921, U.S. Nat. Mus. Bull. 13:337p.) records: "I have seen ring-billed gulls hovering over a flock of feeding red-breasted mergansers and darting down at them as they rose to the surface. They were apparently trying to rob them of or make them drop some of the fish they had caught." However, I can find no published reports of Ring-billed Gulls pirating Lesser Scaup *Aythya affinis*.

On May 3, 1971, at 1615 hrs a group of five male and three female scaup were observed sleeping on the water about 50 metres offshore and at the edge of the ice on Lake Manitoba, near Delta (50° 10'N., 98° 10'W.). Three adult Ring-billed Gulls were resting on the ice about 100 metres from the scaup. At 1645 hrs the scaup started diving for food. The gulls immediately responded by flying to the scaup, joining and following them on the water.

Feeding scaup rising to the surface after diving frequently had bits of "water-weed" hanging out of their beaks. A scaup with food streaming from its beak was immediately set on by a gull; the gull rising one or two metres in the air, darting down onto the duck and snatching at the food in its beak. Most often the scaup would drop the food and evade the attack by diving or swimming. Scaup surfacing without food protruding from their beaks were not attacked. A scaup "presented" food on average once every four dives.

The Gulls continued to attend and harry the scaup during the entire time that they were feeding. At 1735 hrs the ducks stopped diving, and began to bathe and preen. They were then deserted by the gulls which returned to their resting place on the ice.

I am indebted to the Frank M. Chapman Memorial Fund of the American Museum of Natural History, the South African C.S.I.R., and the North American Wildlife Foundation, operating through the Delta Waterfowl Research Station, for cooperation and support during my stay in North America.

W. ROY SIEGFRIED

Percy FitzPatrick Institute,
University of Cape Town,
Rondebosch, Cape,
South Africa

Received August 1, 1971
Accepted August 10, 1971

IN MEMORIAM: LEWIS McIVER TERRILL

W. Earl Godfrey

National Museum of Natural Sciences, Ottawa

Lewis McIver Terrill, for more than 60 years a member of the Ottawa Field-Naturalists' Club, died at his home in Ulverton, Richmond County, Quebec, on December 22, 1968, in his ninety-first year. Born in Montreal on October 30, 1878, he was one of five children of Frederick William Terrill, lawyer, and Alexandrina Anne McIver. He lived most of his long life in the Montreal region, in Mount Royal Vale, Montreal West, Westmount, and St. Lambert. In 1953, he moved to Ulverton.

From early boyhood Terrill was intensely interested in the outdoors, and as a youth he often visited Sir William Dawson, at the Redpath Museum of McGill University, who was the only outstanding naturalist in Montreal at that time. Sir William quickly recognized the boy's genuine interest in natural history and took the trouble to guide him and lend him books. Lewis always remembered this and felt that he owed much to Sir William Dawson.

Although opportunities for a career in biology were few in those days, Lewis nevertheless wanted to attend university. In this he was thwarted by the death of his father in 1902 for he was needed to help support his mother and sisters. He worked at various jobs, mostly outdoor ones, until 1920, when he joined the staff of the Merchant's Bank. Two years later he was transferred to the Bank of Montreal. He was retired on pension from that institution in 1942 but on the very next day after his 'retirement' he entered British Metals Corporation and continued to work there until 1950. He remained a bachelor until 1937 when he married Elizabeth Edith Abbott, daughter of Mr. and Mrs. Arthur E. Abbott, and a granddaughter of Sir John Abbott, a former prime minister of Canada. Mrs. Terrill, who survives him, actively shared his interests in natural history and herself was president of the Province of Quebec Society for the Protection of Birds.

Although Terrill was never employed in a biological position, he spent as much of his spare time as possible in the field in nature study. He was an expert field observer, capable of instantly recognizing by ear most of the local birds. His ability to find bird nests astounded many a professional. Birds were his greatest love and his interest in them never waned but he recognized a close relationship between birds and plants and later added botany to his studies.

Lewis was never happier than when with back pack, binoculars, and rubber boots, he was off for a whole day in any kind of terrain but preferably marshes or bogs. Lanoraie bog, the old Roundhouse marsh at St. Lambert (almost non-existent now), and the Gaspé peninsula were his favorites. He meticulously recorded his field notes each day and later transferred them to four immense permanent ledgers. Some of his notes go back seventy years and form a unique long-term record. It was his ambition to write a comprehensive publication on the birds of Montreal. So completely absorbed was he, however, in seeking more data that he neglected the writing of the book he was so well qualified to do. This is a sad loss to Montreal ornithology.

He immensely enjoyed a Saturday afternoon field trip with the local P.Q.S.P.B. bird club. Members brought great quantities of food on these outings and Lewis liked making tea. Water was not so polluted then and many a time his billy tin would boil water from marsh or small stream much to the horror of some fastidious members who, however, eventually drank his 'pollywog tea' with more or less relish.

Terrill was a fervent conservationist and, long before it was fashionable to do so, he often expressed a dread of what man was doing to nature. He actively opposed the destruction of the forests and the draining of marshes. Once

he is said to have taken a devilish delight in watching an offending tractor wallow and founder into hub-deep helplessness in the mud of a field he knew to have been converted from marshland.

A charter member and founder of the P.Q.S.P.B., he was its first president in 1917, and he continued to serve on its Board until 1953, when he retired to Ulverton to live. For many years he edited the Society's Annual Report, the bulk of which was devoted to the year's most significant bird records in the Montreal region.

Lewis Terrill was the last of an older generation of P.Q.S.P.B. members that included Henry Mousley, Napier Smith, Harry Jackson, W. J. Brown, W. S. Hart, and J. A. Decarie. In 1907 he joined the American Ornithologists' Union which, in 1947, recognized his ornithological work by making him an Elective Member. He was Honorary President of the St. Francis Massawippi Bird Club from 1954 until his death.

In the course of his career, Terrill made various carefully-prepared collections of biological material mainly in southern Quebec. His collection of some 2,000 sets of bird eggs, with data, has been divided mainly between Redpath Museum and the National Museum of Natural Sciences. The latter institution received also his collection of about 100 nests. His 300 bird skins, collected between 1914 and 1933 in southern Quebec, went mainly to Redpath Museum. Some 10,000 specimens of plants, most of them named, were divided among Bishop's University, Redpath Museum, and the National Museum of Natural Sciences.

Terrill's enthusiam for natural history was matched by his impressive physical vigor and mental acuteness, a combination that kept his field work productive throughout his long lifetime. Through tireless observation, meticulous notes, and publications he has contributed abundantly to a better understanding of the avifauna of his native province. His numerous lectures, illustrated by slides made from his own expertly hand-coloured photographs, to schools, societies, church groups, and natural history clubs have made countless people conservation minded. His well-prepared specimen collections, donated now to research institutions, will continue to advance knowledge for a long time to come.

Lewis Terrill's warm enthusiasm and kindly guidance gained him the esteem and affection of a great variety of people in all walks of life. He particularly enjoyed helping young people and he was largely responsible for starting several young Montrealers on the road to outstanding professional careers in the natural sciences. His favors were not confined to the young, however, for he left to a great many others of all ages the priceless legacy of a lifetime avocation in the outdoors.

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Letters

Herbicides: A Critical Look at their Use in Forest Management

Herbicides are substances that kill plants. They are chemical in nature and have been used by man for thousands of years. After the third war between Carthage and Rome the Romans destroyed Carthage in 146 B.C. They plowed the land and sowed it with salt so that all living things would be destroyed. Salt had undoubtedly been used as a herbicide before this, but it is only in the last 25 years that there has been large-scale use of chemical herbicides. In Ontario forests about 30,000 acres are sprayed with herbicides every year (Brunelle, 1970 — March 5th Legislature of Ontario Debates). There are at least 130 types of chemical herbicides today that can result in perhaps 8000 different formulations by combining two or more types by varying the bases used; e.g. diatomaceous earth, water, or an organic solvent such as alcohol. These thousands of combinations all have different properties of toxicity and persistence. This formidable array of herbicides is almost impossible to assess. Fortunately, however, relatively few of these many herbicides are in widespread use. 2,4-D is the most used herbicide in Ontario forests, followed by 2,4,5-T (Brunelle, 1970) and in Britain 2,4-D and MCPA are the two most used herbicides (Mellanby, 1967).

When considering the question "Should herbicides be used in forest management?" we must be aware that the word herbicide has become a charged word and may evoke an emotional response. This is unfortunate, when it occurs, because the subject is important and must be considered as logically as possible. In order to discuss herbicides and forests thoroughly, it would be necessary to be a good forester, a good ecologist, and a good chemist, but as such a combination is unlikely to occur the subject is possibly best discussed by an ecologist. Ecology is an integrating science and must take a multiple factor approach. How and if herbicides are to be used will ultimately be decided only by considering all the ramifications in relation to the ecosystems involved.

First, what are we talking about? Are we discussing carefully controlled use in a nursery or even a plantation or are we discussing aerial spray programmes of large size in otherwise relatively unmanaged areas? The answers to specific questions will vary. However, are there any general dangers or possible dangers?

The answer is probably that there are some general hazards. A number of hazards are possible with the use of herbicides. Some herbicides are very toxic to animals, including man; e.g. arsenic and phenol compounds (Mellanby, 1967). Some are persistent in the environment, e.g. Chlorfenac (Sutton, 1970); some are suspected of serious side effects such as causing cancer, still births and deformed births in human populations (Whiteside, 1970).

Are these dangers real or the products of overworked imaginations?

Some herbicides are toxic and this is unquestioned. The arsenic and phenol compounds mentioned earlier are very poisonous and their use is limited and usually carefully controlled. But on further investigating toxicity we encounter the "Ambiguity Problem". There seems to be a lack of agreement on what constitutes toxicity and which chemicals are toxic.

The "Ambiguity Problem" should be explained. In preparing this paper it very soon became apparent that there is a lack of agreement on facts and on the interpretation of facts in relation to herbicides. Also it was noted that occupation seems to have a relationship to the point of view of the researcher. Generalizations are often dangerous but danger seems to go with the herbicide business and so the generalization can be made that chemical company and federal government (mostly U.S. but perhaps some Canadian as well) employees are of the I-can-see-no-evil school, while university and provincial government employees are on the fence or of the I-can-see-no-good school. All groups contain reputable scientists and writers and publish in reputable publications. Because of the "Ambiguity Problem" facts and interpretation can be given but often conclusions must be left to the reader.

Let us return to toxicity. Even water is toxic if taken in sufficient quantities. Table salt is toxic if taken in moderate quantities, and 2,4-D and MCPA will kill man if taken in a quantity of about ¼ pound (Mellanby, 1967). However, substances are usually not considered very poisonous unless they will kill with very small amounts such as 100th of an ounce. A substance such as cacodylic acid (Silvisar) can kill an adult with a dose of one ounce (Orians and Pfeiffer, 1970) and

cause other unpleasant symptoms such as headache, vomiting, diarrhoea, dizziness, convulsions and even paralysis with lesser amounts. Yet cacodylic acid is said to be "Much safer than inorganic arsenicals" by Sutton (1970), and House *et al* (1967) are ". . . impressed by the low oral toxicity." But 2,4-D is considered lethal to some fish (Salmonids) at 0.5ppm for 24 hours, a concentration that can occur in small streams treated with herbicides (Orians and Pfieffer, 1970). Yet House *et al* (1967) state ". . . the direct toxicity hazard to people and animals on the ground is nearly nonexistent."

Herbicides are poisonous to plants primarily, and sometimes herbicides kill the wrong plants. This can happen because of too high concentrations of the herbicide or sometimes for less predictable reasons. Kozlowski *et al* (1967) showed that at high temperatures normal amounts of simazine (30°C, 86°F) caused mortality in red pine seedlings, and atrazine resulted in 100% mortality at two pounds per acre (Treshow, 1970). Simazine is used in nurseries in Ontario. In 1965 a Jack Pine release programme (Tieman *et al*, 1965) using 2,4-D and 2,4,5-T resulted in damage to the pines. Wu *et al.* (1971) found seedling development in *Pinus resinosa* to be greatly altered by both 2,4-D and picloram at 50 ppm. Sometimes when pesticides are used in combinations toxicity is increased, and this is especially true if a herbicide is mixed with an insecticide (Treshow, 1970). If volatile esters are used in order to gain quicker penetration of leaf tissues the results can be far-reaching, — as far as 30 to 40 miles away from the spray area where the isopropyl ester of 2,4-D was used (Freed, 1965).

Another negative aspect to herbicides is persistence. Some herbicides can remain unchanged in the soil for long periods of time. This can result in a build-up of the substance and in adverse and cumulative effects to organisms involved with the system. Once more we must face the "Ambiguity Problem".

Anderson (1970) states about 2,4-D and 2,4-5-T, "In fact, experimental work for a number of years has indicated that the life of these chemicals in the soil is short . . .". House *et al* (1967) state, "2,4-D and 2,4,5-T are not considered to be persistent herbicides." These authors show no concern regarding persistence of these two very much used herbicides. However, Treshow (1970) says, "In areas having little precipitation, residues tend to persist in surface layers of the soil, acting as soil sterilants." House *et al* (1967), discussing persistence of 2,4-D and 2,4,5-T in water, say that persistence is in terms of days. But Hemmett and Faust (1969) question the favourability of aquatic environments for rapid disappearance of 2,4-D as one study in cold, low 0_2 content water revealed persistence for at least 80 days. Hemmett and Faust (1969) also question whether the kinetics of 2,4-D biodegradation have been extensively examined. If 2,4-D is toxic to some fish and if 2,4-D does not readily decompose in cold low 0_2 water, what are the consequences in relation to deep cold lakes that are common in Canada's Boreal Forest?

Some herbicides are admitted to persist for 2 to 5 years, and are sold on this basis. How long will these persistent herbicides last in cold northern waters? A relatively new herbicide, picloram, is said to break down completely in 4 to 5 years under Canadian climatic conditions when applied at recommended rates (Tordon Herbicides Manual, p. 7; no date, but probably 1970). Yet this same chemical is said to be one of the most persistent herbicides known and a herbicidal analog of DDT (Whiteside, 1970). This same compound has been said to be the most toxic chemical toward plant life ever developed (Graham, 1970). Some of the triazines (soil sterilants) are very persistent in soils, especially in cool dry climates (Sheets, 1970). This is also true of some of the substituted areas such as CMU and Monuron (Russell, 1961; and Sutton, 1970). Persistence in any pesticide must be carefully considered as the long term effects are incompletely understood (Foy and Bingham, 1969).

Finally, in the general hazards department, we must question possible side effects and cumulative effects of the widespread use of herbicides. Some of these effects have already been mentioned, such as wind drift of volatile herbicides killing or injuring non-target crops and possible toxic effects of 2,4-D on fish populations. Much more controversial possible side effects have been suggested. In 1969 the U.S. National Cancer Institute conducted experiments that suggested that 2,4,5-T caused cancer in rats (Graham, 1970). This charge has apparently not been repeated but another attack has been made on 2,4,5-T. This time it is associated with increased birth deformities and stillbirths. Deformities occurred in rats even at very low dosages (21.5 mg/kg) much below a lethal dose (Whitehead, 1970). These results caused the U.S. government to curtail the

use of 2,4,5-T in October, 1969 (Nelson, 1969) and influenced the Canadian government to follow the same course in May, 1970 (Anderson, 1970). The herbicide was, however, reinstated in Canada in June. And once more there is ambiguity. The Surgeon-General of the U.S. does not consider that 2,4,5-T has caused human birth deformities and neither does the Canada Department of Agriculture (Anderson, 1970). Yet Whiteside (1970) considers the 2,4,5-T used in Vietnam to be 200 to 10,000 times more likely to cause birth deformities in rats than thalidomide. Egginton (1971) states the 2,4,5-T used in Vietnam to be responsible for a sharp increase in both stillbirths and birth deformities in areas that have been heavily defoliated. If 2,4,5-T is involved it is thought (Whiteside, 1970) that it is perhaps a contaminant of 2,4,5-T called dioxin that is most responsible for the side effects. The amounts of dioxin have been reduced but are still present and dioxin is very persistent and very toxic. It is perhaps worth noting that reproduction in quail and pheasants was reduced or inhibited by feeding 2,4-D (De Witt, 1964).

The above are the charges against herbicides in general. What about forestry practices in general? First, let us consider nurseries for forest trees. These are of limited area and are intensively managed. If herbicides are to be used the least possible dangers should obtain in tree nurseries. The triazine compounds are much used in nurseries. These are persistent and break down slowly with almost no decomposition of simazine and atrazine, at least during winter months, and there is a tendency for atrazine to accumulate in lower soil levels (Sheets, 1970). The advantage of herbicides over manual and mechanical methods is lower cost. At Orono, Ontario, \$250.00 per acre, about a 35% reduction, was saved by using a herbicide. During periods of high unemployment would it be better economics to pay this money to workers who would return most of the money to local businesses or is it better to buy chemicals from some remote factory, probably foreign-owned?

Managed tree plantation areas are somewhat similar to nurseries and the same comments would apply. This is assuming continuous management on productive land with high expected yields.

The last category of forest lands is large areas of cut-over and burned-over second growth areas that are so abundant in the boreal forest and other Canadian forest areas. These areas, because of their size, difficult terrain, and relatively low productivity are prime targets for relatively inexpensive aerial spray programmes. The ecological consequences to the ecosystem of such programmes should be carefully considered. The problems of the inter-relationships of the ecosystem are more basic and more complex than are the problems relating to characteristics of various herbicides. The pesticide problem is essentially ecological (Moore, 1967), and " . . . no matter how much we rationalize, the fact still remains that we are pouring chemicals onto the "Web of Life" and we have little knowledge of the immediate or long term ecological effects." (Fry, 1969).

What are some possible ecological effects of large-scale herbicide use in forests? Great stress is put on the effect on the soil and soil organisms because of the great importance of soil to productivity. A number of studies have been done on the effect of herbicides on soil organisms. Anderson there are no adverse effects to soil organisms from herbicides used in normal agricultural practice and says (Anderson, 1970) specifically in relation to 2,4-D that after 16 years of study there was no change in the microflora of the test plot. Edwards (1969) found that DNOC and simazine affected soil invertebrate populations for at least five months. Kaiser *et al* (1970), discussing effects of triazines on the soil micro-organisms, conclude that the results of a number of studies are contradictory with some authors finding inhibition, some finding stimulation, and some finding no effect. Soil organisms are dependent on soil nutrients and soil organic material and two recent studies indicate profound effects by herbicides in this regard. Likens *et al* (1970) studied the removal of nutrients by water from a deforested area that was treated for two years with Bromacil, a persistent broad spectrum herbicide. Stream flow increased 30% but stream water concentration of calcium increased by 417%, of magnesium by 408%, and of potassium by 1558%. Malone (1970) treated a fescue meadow with Dalapon and found that soil bacteria increased and as a result there was a 15 to 22% greater loss of organic content in these soils than in control plots. Obviously many questions remain unanswered, such as will short term productivity gain be paid for by long term soil losses?

The object of spraying with herbicides in most cases in Ontario forests is to release desirable softwoods from hardwood competition. Some studies such as Cayford (1957) and Steneker

(1963 and 1967) have shown that release of spruce from competition by cutting out hardwoods increases spruce wood production.

If herbicides are used as aerial sprays in such thinning operations certain known costs are involved. There is the cost of a spray operation itself and of possible damage to trees such as pine, which are often quite susceptible to the herbicides 2,4-D and 2,4,5-T which are usually used (Fry, 1971). There are also ecological costs, such as possible increased rate of leaching of the soil and possible poisoning of wildlife which browse on the sprayed foliage (this may be due to high nitrate content induced by the herbicide or to increased palatability of poisonous plants such as cherry). The alteration of the floral complement of an area can occur. Susceptible species of plants will be removed and resistant species such as raspberries, dogwood, and mountain maple will become more common. These less susceptible species then must be removed, using even stronger herbicides or higher concentration if future spraying is required. These alterations result in a simpler community both of plants and animals. One of the axioms of ecology is "a simplified habitat is extremely unstable" (Egler, 1964). The simpler the habitat the more management that is required to maintain it. Many questions come to mind.

What are the costs? What happens to the varied herb layer in a forest? What happens to the deer that feed on aspen and other broadleaved trees and shrubs? What happens to other animals that are deprived of a food supply, such as beaver? What happens to moose and speckled trout without beaver? What happens to the birds? What happens to blueberries, which are very susceptible to 2,4-D and 2,4,5-T?

Why should aspen be destroyed, anyway? Release programmes result in more spruce wood but not in more wood, in less wood, if the aspen is included (Steneker, 1963). In another few years we could be talking only about cellulose production and not fibre production. Weed species of today are prime timber tomorrow. This has been true ever since lumbering started in Canada. Aspen will out-produce black spruce 2:1 on a 60 year rotation on Site — Class 1 (Plonski, 1960). Foresters of the future could well shake their heads in wonder at "release programmes" of today. If short rotation practices become common then ecologically it would be sound in much of the boreal forest to have a natural early succession stage suited to these sites, such as the hardwood stage which adds nutrients to the soil, rather than the much later shallow-rooted conifer stage.

If herbicides are used selectively and if the selection is based on good ecological studies, herbicides are potentially very constructive (Egler, 1968). For example, Back-pack sprayers and injection instruments are easily controlled and can result in stable, long lasting treatments to natural situations (Egler, 1950).

Finally, a plea for beauty and variety in our increasingly ugly and uniform environment. Some of our northern forests must be left in a primitive state — with the absolute minimum of interference. But most must be multiple use areas. Perhaps recreation will yet be the most important use of the boreal forest. Hunting, fishing, and camping are best accompanied by at least a semi-wild situation, and not by brown-outs from spraying and the monotony of pure stands of rows of black spruce. If we manipulate too much the break-even point will be passed and all the king's horses and all the king's men will not put our forests together again.

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PAUL BARCLAY-ESTRUP

Department of Biology,
Lakehead University,
Thunder Bay, Ontario

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Reviews

Essays in Plant Geography and Ecology

Greenidge, K. N. H. (editor). The Nova Scotia Museum, Halifax, N.S., ix + 184 pp., illus. 1969. $3.00 (paper).

This volume contains eight papers presented at the Symposium in Terrestrial Plant Ecology held in October, 1966, at Saint Francis Xavier University, Antigonish, N.S. Each of the papers is followed by a discussion which, in several instances, provides a more adequate review than can be given here.

The "Essays" form an interesting whole, despite — or perhaps because of — the fact that the papers show how little we really know about vegetation, communities and patterns and, last but not least, plants. Most of the papers also show that ecology, in the broad sense, is once again settled in a groove.

Thus, P. F. Maycock's "The spruce forest complex of the Polish Carpathians" is one more paper which shows that ordination and classification are not necessarily at odds. Maycock concludes that his treatment reveals, besides continuity, many interrelationships of species and gradients. But little is added to the knowledge of these same spruce forests given in "Prodromus der Pflanzengesellschaften", Fasz. 6, Klasse der Vaccinio-Piceetea, 1939. It may be noted that Maycock's designations of the Piceetum myrtilletosum and P. abietetosum as "associations" are erroneous; both are sub-associations, as the ending "-etosum" indicates. Modern use of sub-associations acknowledges that these units are often "transitional" and form links in a continuous series of associations.

"Vegetation and the equilibrium concept of landscape" by J. C. Goodlett shows that the formation of landscapes, rather than a series of erosion cycles, is a continuous process of adjustment between topography and vegetation which may be quite rapid and does not necessarily require many thousands of years. Goodlett's arguments seem plausible enough and deserve the attention of ecologists who may well find that fluctuations in floristic composition may be a response to changes in topography rather than succession.

Two papers deal with patterns in vegetation. One is "Studies of vegetation in northeast Greenland" by H. M. Raup; the other "Alpine community patterns in relation to environmental parameters" by L. C. Bliss. Both papers follow conventional methods. Raup concludes that the patterns observed can be ascribed to species tolerance and is rather independent of species association. Bliss observes that patterns in alpine vegetation are similar in both the Northern and Southern hemispheres, with cushion plants and dwarf shrubs as the main life forms, despite the difference in overriding environmental factors. It would be possible to list a long series of papers of similar studies, most of which reach similar conclusions, and the main interest of these papers is the locations studied.

In "Plant community as a landscape feature" J. S. Rowe proposes to substitute the landscape ecosystem for the community ecosystem. The landscape ecosystem combines landform and vegetation in three dimensions, thus dealing with "volume". Though this is a novel approach to an old problem, and despite claims that his concept clarifies parts of the problem and places others in a new light, Rowe only places old ecological problems on a different scale, but does not bring the solution closer.

A similar critique may be leveled at D. A. Livingstone's "Communities of the past", which deals with difficulties encountered in the use of pollen profiles to reconstruct plant communities of bygone times. One may sympathize with the palaeo-ecologist, but it might have been more interesting to give more room to the possibilities of the future, now mentioned in three paragraphs and less to a review of the present state of affairs now occupying about 11 pages.

W. H. Drury reviews the old controversy about Fernald's nunatak hypothesis and relicts in general, in "Plant persistence in the Gulf of St. Lawrence". If any illustration of our limited knowledge of plants is needed, here it is. Drury concludes that in future research "Most of all, detailed studies are needed of the ecology or natural history of individual plant species and local factors affecting their distribution at present." Apparently, not very much has been accomplished in the 40-odd years since the controversy arose.

F. H. Bormann discusses "A holistic approach to nutrient cycling problems in plant communities" using six sites in New Hampshire, each with Maple-beech forest. Measurements in these systems show that the nutritional balance is very

stable, due to the biological fraction of the system. This can hardly be surprising in view of the great potential longevity of such systems.

Despite the rather routine character of the essays they are well worth reading and add to our general knowledge. And, maybe the Canadian Botanical Association should look into the possibility of organizing one or two symposia on ecology each year, preferably alternating between eastern and western Canada. The papers might be published as a special issue of an existing journal; this might shorten the interval between symposium and publication, and improve the quality of the illustrations.

J. LOOMAN

Phytosociology Section
Forage Production and Utilization
Department of Agriculture Research Station,
Swift Current, Saskatchewan

Growth and Development of Trees. Volume I. Seed Germination, Ontogeny and Shoot Growth

By T. T. Kozlowski. Academic Press, New York and London. 1971. 443 p. 147 illustrations. $23.00.

This new addition to the Physiological Series edited by Professor T. T. Kozlowski is a welcome supplement to the all too sparse literature on tree physiology. In the past tree physiology investigations have tended to lag both in quality and quantity behind long established investigations of physiology of plants of economic value in agriculture. Understanding the processes of these agricultural plants has been vital to evolution of modern efficient management practices. In the past the forester has mainly taken an empirical approach to tree crop manipulation. Although this has worked very well, progress would undoubtedly have been much faster (and mistakes far fewer) if more had been known about the processes of the trees and the ecosystems of which they are a part. The apparent lack of interest by foresters in the processes of trees still persists to a certain extent today. It is hoped that this book will stimulate interest in trees as organisms rather than economic units and create an awareness of the real need for more information on their physiological processes.

The author has written a great many papers on many aspects of tree physiology (e.g. growth, water relations, herbicides, seed germination), and has been the editor of several collections of physiology papers. He has played a major role in bringing together large amounts of information that the forester can easily understand and absorb.

This book is the first of two volumes, and deals with seed germination, ontogeny and shoot growth; the second volume in preparation is concerned with cambial, root and reproductive growth. The two volumes are aimed at an audience of upper level undergraduate and graduate students, investigators and growers. The emphasis is "largely developmental, with strong ecological and physiological overtones throughout". The book deals with structural and growth characteristics of trees, seed germination and seedling development, phase changes, aging, bud development and shoot expansion, leaf growth and development, variation and control of shoot growth. It contains a wealth of information and the illustrations are well chosen. The reviewer's copy had a binding fault obscuring a number of references in the bibliography, but the book is glossily well produced and typographical errors are few for a first edition.

A reader's response to a text book such as this is greatly influenced by what he expects to find in it. In this case the reviewer hoped to get a balanced critical synopsis of knowledge about tree growth and development, a brief coverage of conceptual aspects and a forward look at future needs. This expectation was not completely realized and, even after reducing his expectations, the reviewer found that the book aroused mixed feelings of admiration and frustration. The admiration was based on the broad sweep of the book and the competence of the author in the way he describes complex topics; the frustration was due to the imbalance of the book, the omissions, the absence of intellectual stimulation, and the difficulty of locating specific topics in the text.

Some important subjects are given very brief treatment or are omitted entirely, and others are dealt with in great detail. A surprising omission from such a review of current knowledge on tree growth is a discussion of the classical growth analysis techniques of Watson and his colleagues, involving computation of net assimilation rates and relative growth rates. Relative growth rate has a special meaning for scientists concerned with plant growth. In this book it is used in the

loose sense of slow, moderate, rapid etc. growth. It is difficult to see how this omission can be repaired in the later volume. A chapter on the mathematical aspects of growth would have greatly added to the value of the book.

A brief synopsis of the current state of knowledge about tree photosynthesis would have been very welcome. Photosynthesis is mentioned very briefly, and is only given ten page references in the subject index. The subject index itself is meagre with remarkably few page references per key word (e.g. macronutrients 7 p., genetic variability 1 p., competition 3 p.). The purpose of such a text book is to give rapid access to information; the subject index is one key to its success. When a reader wishes to look up "Nutrition" he must search the index for such terms as "Macronutrients", "Fertilizers" or "Minerals". If he wants to look up "Potassium" he finds no entry and goes on to "Nutrition" which still has no entry. In later editions it is suggested that the author give a much more detailed index. Index compilation is the most tedious part of writing any book, but it is well worth the trouble to do it well.

The review of seed germination and seedling development is well done. Even this section, however, suffers from an absence of critical appraisal of the papers quoted. While it is difficult to reconcile brevity and clarity with a critical approach, such an approach gives reviews a dynamism that is well worth the extra pages.

If the reader is seeking an introduction to tree growth in general, or an introduction to some particular aspect of the subject, he will find this book most useful. On the other hand, an experienced researcher will be disappointed if he seeks in this book a discussion of conceptual aspects of tree growth. The book is a mine of facts with the minimum of philosophy. It is hoped that after this book ths author will draw on his vast knowledge of the literature to discuss in detail and in depth a more limited aspect of tree growth.

In spite of these shortcomings the book will be a welcome addition to the bookshelves of foresters, horticulturists and all those interested in understanding how a tree grows. The text is written with great simplicity and is edited so that doses can be absorbed without too much effort.

A. CARLISLE

Petawawa Forest Experiment Station
Canadian Forestry Service
Chalk River, Ontario

The Economics of Abundance: A Non-Inflationary Future

By Robert Theobald. Pitman Publishing Co., New York. 1970. 152 p. $5.95. Available in Canada from Copp Clark Publishing Co., Toronto.*

This provocative book begins with an assumption that too few economists are willing to make but one which is becoming increasingly evident: many of our current problems relating to unemployment, inflation and the deterioration of our natural environment can be traced to a malfunction of our economic institutions. Economic institutions which were developed in a time of real scarcity either become inoperable or operate perversely when the underlying condition changes to become one of potential abundance. Since current scarcity is contrived and not real, market forces fail to operate effectively and resources are allocated ineffectively or improperly.

The fear of scarcity permeates the society and consequently power nodes develop (large corporations, powerful labour unions, etc.) which vie for increasing shares of national output. This form of behaviour leads to an outcome where inflationary patterns are reinforced. Governments add to the problem when, operating with a mixture of perceived scarcity and political acumen they attempt to reduce unemployment, i.e., to provide jobs. Theobald claims that governmental action of this type misses the point: in a time of abundance the problem is one of unemployability rather than unemployment.

Theobald presents a sketchy review of the development of economic thought and summarily dismisses most of micro and macro economics as being inadequate, misleading, inaccurate, inapplicable or out of date. He cites various sources to substantiate his findings but, unfortunately, asks the reader for unquestioned faith since he provides us with no footnotes.

He opts for the techniques of cybernetics and systems theory. The problem, for Theobald, is that we have allowed (consciously or unconsciously) the feedback channels to become clogged and consequently wrong actions are taken since the information is wrong or distorted. His favourite example is that of a thermostat. When placed in a refrigerator or too near a furnace (misinforma-

*The views expressed are not necessarily those of the Science Council.

tion) it functions incorrectly and makes the occupants of the room too cold or too warm (inflation or depression).

Theobald presents an economic policy which recognizes the fact of potential abundance. In his scheme all people would be entitled to a tax-free basic economic security (B.E.S.) — similar to a guaranteed annual income. In addition the individual would be entitled to a committed spending sum (C.S.) based upon his previous earnings. In a society where lack of employment is recognized to be a function of abundance the individual could opt to indulge in non-market activities (called "consentives") and be funded on the basis of his B.E.S. plus C.S.

Theobald has, it appears, correctly identified several major problems which must be recognized and handled in an intelligent manner. He recognizes the profound discontinuity arising from institutions and theories which developed in a time of real scarcity. He further demonstrates how inappropriate policy measures only serve to exacerbate the problems. And since so few alternatives have been offered one should perhaps not be too harsh with the simplistic ideas which Theobald offers to solve all of our economic (and many non-economic) problems. For example, Theobald overlooks the very real problem of how new institutions can be created and over time replace their older malfunctioning counterparts (he assumes away, for example, the existence of much of the stock market). In his new grand scheme which is put forth with such zeal (Theobald must be classified as a "true believer") little is said about who owns what and where the new control points will lie. Much new jargon is introduced and there appears to be an almost total acceptance of the notions of cybernetics and systems theory.

Briefly then, Theobald has raised some important questions and while his own proposals are vague and simplistic, the very existence of this book will, one hopes, cause economists in government, academia and industry to pause, reflect and perhaps begin thinking of new ways to allocate resources in a society where the old assumptions are no longer applicable.

ARTHUR J. CORDELL

Economic Adviser,
Science Council of Canada*
Ottawa.

Oil on Ice. Alaskan Wilderness at the Crossroads

By T. Brown. Sierra Club Battlebook; in Canada available from Clarke, Irwin and Co., Toronto. 1971. 160 p. $1.95.

The cover design, layout, choice of type size and type style and the choice of paper are all excellent and combine to give a reading time of approximately two hours.

The book comprises an introduction by Richard Pollak, the main section comprising 11 chapters by Tom Brown, then two short essays, one by Wayburn and one by Marshall, and closes with a bit of advertising on the Sierra Club.

There is a map of Alaska which the reader will find useful and a preface of a letter from Samuel A. Wright written on February 15th, 1969. The reason for its inclusion escapes me and, taken at face value, the reader should stop right there. The letter contains nonsense because in essence it says that the introduction of a new winter road in 1969 ". . . may have written the beginning of the end of the great caribou herds, majestic mountain sheep and the wolf" and "Fortunately the Brooks Range is in the State of Alaska in the United States of America, and we can save it now. Next month, tomorrow, will be too late." As this book was sent to me to be reviewed in May 1971, two years after that letter was written, if the author is correct it is obviously too late to do anything, which is nonsense, and I have not been able to find a responsible wildlife scientist who thinks the winter road through the Brooks Range will destroy all the caribou, mountain sheep and wolves in North America.

Turning to the body of the book itself, the Canadian reader will be irritated. Starting with the map of Alaska, there is no entry of any sort on the Canadian side of the Alaskan boundary Some roads are shown and the Yukon River is shown. This insular approach is evident throughout. There is no reference to the alternate route down the McKenzie River valley. There is no reference to the pipeline research at Inuvik and yet they make references to the horrors of a pipeline buried deep in the permafrost. Reference to the Inuvik experiment would show that pipeline buried in permafrost is not buried as in the normal temperate zone. It is covered with gravel and sits on a gravel bed, and the gravel mound is entirely above the permafrost. The pad of gravel

between the pipe and the permafrost is sized to keep heat conduction to an acceptable level. What is acceptable is the question to which the research addresses itself.

Also there is no mention of the major spill of petroleum products that took place in Hudson Strait last spring that was cleaned up very successfully because it was a shoreline spill. The shore ice acted as a dam and prevented the gasoline and arctic grade fuel oil from reaching the water. Most of it was subsequently pumped up on top of the ice and burned.

There is no mention either of the world's first major oil spill in a cold environment which took place following the grounding of the tanker Arrow in Chedabucto Bay on the 4th of February 1970. Admittedly the conditions were not arctic but as sea ice was forming at the time the conditions were not dissimilar to certain periods in the arctic and certain conclusions can be drawn. The only Canadian scientist who is quoted is Dr. Richard Warner of Memorial University and he is quoted on biodegradation of oil in a water environment, a subject which is well outside his area of specialization and on which there are at least three U.S. scientists with international reputations who could have been consulted.

The contents are a curious mixture of fact, fiction, polemics and passages that are really quite attractive.

I suppose if one reads a battlebook of the Sierra Club one must expect it to have all the trappings of a wartime information service, where historically there has always been a tendency for both sides in the conflict to claim justice, righteousness and God to be with them and to consider this as a licence for gross distortion of the facts. If the reader of this review will, tongue in cheek, give me this caricature of a definition of PR in war then Oil on Ice fits that caricature perfectly.

To give you some specific examples, on page 11 Pollak states that, "What they (the enemy) don't readily admit is that a pipeline break in Alaska would make the Torrey Canyon and Santa Barbara disasters seem like so much spilt milk". Over most of its length a break in the pipeline would be a break that would be contained by land mass, and I would like to assure the reader that even major pipeline fractures on land are nothing like as damaging to the environment or nearly as difficult to clean-up as an equivalent spill on water. I have examined the records of pipeline spills both in North America and in Europe and I have a little first hand experience in dealing with the Arrow spill in Chedabucto Bay, and I can assure both Mr. Pollak and the reader that I would much prefer to deal with a spill on land than a spill in water. A few lines further on he talks about the pipeline spill destroying fish and wildlife for miles around. Mr. Pollak should really look at the record of pipeline spills and the area which the oil covers.

On page 16 Mr. Pollak says, "A fraction of that oil would turn the sound into another Lake Erie and seal a slick lid over the Gulf of Alaska's multimillion-dollar fishing industry for years to come". This also is nonsense because Lake Erie is not in trouble from oil spills and Mr. Pollak really ought to look at the record of the fish catch in Chedabucto Bay following the spill of the tanker Arrow. Lobsters, ground fish and pelagic were all caught in quantities such that we were unable to establish any measurable effect of the oil on the fish. Some fishing gear was fouled with the oil but this was cleaned by those on our team working the fishing gear laundromat invented for the purpose, and the technology on this is now freely available to everyone in the world.

Finally, typical of all warring factions, Pollak for the Sierra Club sees only the complete defeat of the enemy. On page 24 he states, "The oil companies should dismantle their rigs and go home". I suggest that looking only at total defeat and capitulation on the part of one's enemies is trying to turn back the pages of history, which no one has yet been able to do, and that the modern trend in warfare is to have a negotiated peace. I suggest that Pollak, Tom Brown, the Sierra Club and others would make a far greater public contribution if they would stop behaving like a knight in shining armour mounted on a huge white stallion and, like St. George, about to slay the industrial dragon. They should stick to the facts, which will impress the people enough without distortion, and seek acceptable solutions that will stand the test of time. Then the contribution they will be making to the world in which our children will have to live will be far greater and more productive. Unfortunately, because of the extreme posture of the Sierra Club that shows through throughout this book, it will make a much smaller contribution to understanding and to finding a solution than if the author had taken a less warlike approach.

Turning to the part written by Tom Brown, the first two chapters are not too bad. Chapter 3 has

all the earmarks of a separate battle embedded in the war but I have not felt it worth my while to check the facts so I have no comment.

The article on permafrost is very superficial, which is disappointing because there is a great deal of good and interesting knowledge on the permafrost. It is certainly a major factor in any of man's activities in the north and I am sorry that the author missed the opportunity of informing his readers of its fascinating characteristics some of its habits and how it is very unforgiving if man is ignorant and tries to ignore it.

Chapter 4 is really quite uneven and again loses an opportunity to really inform the public of the problems of waste disposal in the Arctic. I suppose it is forgivable in a battlebook that comparisons are not drawn with southern settlements in which practices are far worse than those outlined as present in Alaska. However, when the author says that septic tanks cannot be used in permafrost he is wrong. I would certainly not recommend it, and it would take a long time to construct, but it is technically possible. I share Brown's annoyance with litter and trash that has been left by earlier activities, in the Canadian north as well as in Alaska, and I join him in encouraging the regulatory authorities to insist on good housekeeping.

Chapter 7 on the pipeline is really quite good but would have been strengthened by some quantitative information on the frequency of earthquakes along the pipeline that are likely to be of damaging severity. This would have given the reader the opportunity for independent judgement. Also I think it is important not to exaggerate the extent of the acreage actually used by the pipeline. Taking the pipeline company's requests for a right of way 100 feet wide along a pipeline route of 800 miles, I think we are talking about 10,000 acres of wilderness being used by the pipeline, if my arithmetic is correct. With accurate contours and details on the magnitude of the possible spills, all of which are determinable, it would be possible to calculate the amount of territory that might be subjected to oil spills. What I am saying is that I am disappointed that Brown has not chosen to take the opportunity to give his readers facts and figures that I presume he has because if one is to work out a good compromise there is no substitute for accurate data and objective judgement.

Chapter 8 on the passage and supertankers is really quite good, but there is one statement which is just so inaccurate that it must be exposed. On page 92 the author quotes Ray Morris as stating, "tankers 'have one of the best safety records in shipping'." This is unadulterated nonsense, on two accounts. First the record of accidents in all shipping is appalling, being seven per cent per year. Would the reader try and visualize his reactions if seven out of every 100 commercial aircraft in the States crashed each year. I think the public would object, and if the same thing happened in Canada I am sure the Canadian public would object, but this has been going on in the world's shipping for years. As a component of this, the tanker record is far from good. 600,000 tons of tanker went to the bottom in the last six months of 1969 which is the last year for which there is published material that I have been able to find. Four supertankers have blown up quite recently under conditions which are not yet fully understood. They were tankers in the 200,000 ton range and yet in spite of this tankers in the 300,000 and 400,000 ton range are being built. The United States has recently put a hold on the development of the SST largely for environmental reasons. They have limits on the lengths of vehicles that can travel the highways of the United States determined on safety considerations and it is about time that the same kind of logic was applied to tankers. Most of the tanker accidents are contributed by those flying flags of convenience, a situation with which the United States is not uninvolved.

There are other minor inaccuracies in the chapter and of course the chapter has nothing to say about the pollution problem of the southern part of the Valdez to Cherry Point tanker route. The Straight of Juan de Fuca, the Strait of Georgia and Puget Sound are a matter of concern to those who live on our west coast.

The final three chapters by Brown are good with only minor inaccuracies but the Editor's Note on pages 130 and 131 returns to the battle front ". . . whatever the safeguards and however well they are enforced, the widespread production of oil in Alaska will inevitably destroy much of that precious environment. That, not compromise, is the issue". How about the people who have lived their lives in Alaska? Are they to be told that they must remain poor while their fellow citizens in the state of Texas live in the lap of oil-filled luxury? Surely we have gained enough intelligence to find a more acceptable solution.

The two afterwords essays are obviously by lovers of wilderness areas. I like wilderness areas but I really think North America, in particular the northern part of North America, is bigger than the state of Alaska. On the other hand, I find it rather difficult to envisage a wilderness area fitting into the following vision described on pages 151 and 152. "Protected wilderness, on the other hand, can remain forever as an increasingly attractive resource that will bring hundreds of thousands of people and, with them, millions of dollars to the state of Alaska." How a wilderness area can be invaded by hundreds of thousands of people with millions of dollars and emerge still a wilderness area in my ignorance escapes me, as does the scare statement on strontium 90 on page 153 which would seem to have been written before the test ban came into existence.

If the reader wonders what the reviewer really thinks about the problems discussed in the Sierra Club battlebook, let me make my personal position clear. I think the oil reserves, whatever they are, on the north slope of North America will be developed. As an environmentalist I am determined to do everything I can to make sure that the development takes place intelligently. Where there are gaps in our knowledge on how to bring that development into harmony with proper respect for the environment, we should do the research and do it well and do it fast. As for bringing the oil out, I am opposed to the use of tankers in the Arctic and I think Humble Oil, even on the partial data they have generated through the cruises of the Manhattan, share that view. I think the building of a trans-Alaskan pipeline through the seismically active zone is unwise with the present state of technology, because according to the information I have no one knows how to build a pipeline to withstand the degree of seismic activity known to exist. Nor do they know how to design terminal facilities at Valdez to withstand the seismic activity in that area. I think the oil should come out by pipeline and I hope routes for the pipeline will be developed that will be within the capability of foreseeable pipeline technology. I am satisfied myself that if we have the determination a pipeline both for oil and gas can be built through permafrost with acceptable environmental consequences, but I am also convinced that to achieve this goal we will have to be tough minded, determined and realize that constant vigilance, inspection and enforcement will be the price we have to pay for an environment we will be proud to hand on to our children. I would hope that concerned people will take this approach because I really think that the days of St. George and the dragon belong in history and not now.

P. D. McTaggart-Cowan

Executive Director,
Science Council of Canada
Ottawa, Ontario
K1P 5P4

Freshwater Fishes of Northwestern Canada and Alaska

By J. D. McPhail and C. C. Lindsey. Fisheries Research Board of Canada Bulletin No. 173. Information Canada, Ottawa. 1970. 381 p., 26 text-figures, 59 drawings and 59 spot distribution maps, 5 colored plates. $8.50.

This book describes the freshwater fish fauna of the Bering and Arctic drainages of Alaska and Canada eastward to the coast of Hudson Bay north of 60° N.L. as well as the southwestern islands of the Canadian Arctic Archipelago and St. Lawrence Island in the Bering Sea. It is divided into sections entitled *Background information* which considers history, geology, zoogeography, classification, format, and identification, *Glossary, Key to Families, Species Accounts* which form the body of the text, *Collecting and Preserving Specimens, References* (14 pp.), and *Index.*

The most valuable contribution in the introduction is the discussion of geological history and zoogeography, fields the authors have been studying over a number of years. Dominating the origin and distribution of the fish fauna is the Wisconsin glaciation, the survival in and re-invasion from 3 major refugia around the periphery of the ice sheet. The authors are well acquainted with the Pleistocene geological literature. The publication in 1969 of Geological Survey of Canada map 1257A *Retreat of Wisconsin and Recent Ice in North America,* when the manuscript was completed, does not materially change their conclusions, although it would be desirable to incorporate this map in the next edition. By analysis of glaciation, distribution, and morphological variation, often at the infrasubspecific level, the authors have been able to deduce which refugia

and dispersal routes were used. Most species, 30, dispersed wholly or in part from the Mississippi refuge, 27 from the Bering refuge, and only 19 from the Pacific refuge. None are known to have survived in the Banks Island refugium, but it is little studied. It would have been interesting to see a map of species density, the result of the interaction of the fauna with geological processes and the present environment. Unfortunately, an overall ecological picture considering the major habitats was not included. This would have acquainted the reader with the environment and helped in zoogeographic interpretation. It would also have been interesting to learn whether fish distributions were correlated with isotherms, the northern limit of the tree line, or surficial geology.

Under Classification and Nomenclature, the authors state their point of view, one which others would do well to follow in regard to genera, — moderate lumping and the acceptance of scientific name changes reluctantly and only in the face of convincing published evidence. In regard to species they favour the criterion of reproductive isolation, but then go on to say:

> "Moreover, in our area, with its complex glacial history, there may be pairs of forms that do successfully interbreed in some lakes although remaining distinct in others. In all these instances, we believe that two forms that occur sympatrically in *any* locality without introgression (i.e. without successful exchange between the two gene pools) are most conveniently treated as two distinct species; intermediate populations arising by introgression can then be labelled as hybrids between these two species."

It does not appear to the reviewer that extensive genetic interchange can be styled reproductive isolation, although post-mating mechanisms have also to be considered. The existence of a minority of non-introgressing sympatric populations might be regarded as evidence that species isolation mechanisms are evolving, but the fact that the majority of sympatric populations are introgressing would indicate the present absence of complete species isolation mechanisms. Their definition tries to predict whether the two forms *will* become species rather than determining whether the two forms *are* species at the present moment.

Cunningly the authors seem to skirt rather than wade into the muskeg, and instead of applying their definition to these situations they employ "*'Coregonus artedii'* complex" or "*'Osmerus eperlanus'* complex." Actually, being advocates of Stark's dictum, "A question would better remain in the form of a question than in the form of an incorrect answer", they are being intellectually honest in admitting that the answers are not yet known. But one hopes they will continue their studies and settle the status of these forms for non-systematists.

Family accounts are followed by excellent illustrated keys to the species. There are fifty-nine species accounts. Eighteen other species and one subspecies which range close to but have not yet been found in the study area, are included in the keys but not in the species accounts.

Most of the information in the species accounts derives from the authors' own original observations and study, making a particularly valuable contribution to the knowledge of morphology, variation, taxonomy, and zoogeography of Arctic fishes. Less is known of the biology of Arctic populations and these sections are supplemented from extralimital literature. In the species accounts the authors display extensive study of material, careful reflection, and mature consideration of alternative hypotheses.

Unlike most works of its genre *Freshwater Fishes of Northwestern Canada and Alaska* provides pleasurable reading. The sentences are free flowing, occasionally lyrical, seldom telegraphic or needlessly technical. Quotes from field notes, ichthyological classics, explorer's accounts, anthropological sources, and personal communications embellish the text. A dry sense of humour pervades the book, so much so that one suspects the researchers of perversely choosing quotations from their colleagues, ". . . a mean pike will consume annually between three and four times its mean annual weight." The editors, not to be outdone, lost the photos the authors provided of themselves and substituted one of McPhail looking like a member of the Mafia and one of Lindsey looking like a plonk-happy trapper.

The editing of this bulletin attains the usual high standards of the Fisheries Research Board in clarity, grammar, and orthography (aside from usage of char for charr). The illustrations and maps are consistently placed on the left hand page opposite the species account. The convenience of this arrangement more than makes up for the slight wastage of space. The low gloss paper reduces page glare and permits good definition in the illustrations. The choice of type face is generally good but less bold subheadings in the species accounts might have been used. Hopefully

some of the colour plates will be replaced by ones of higher quality in the next edition. The photo of Twin Glacier Lake on the dust cover and the map on the endpapers combine with the typography and text-figures to give an overall pleasing effect.

Seldom are clarity, readability and scientific worth so combined as to please both the layman and specialist. It is clearly the finest handbook to appear on any Canadian fish fauna.

DON E. MCALLISTER

Ichthyological Unit
National Museum of Natural Sciences
Ottawa, Canada K1A 0M8

Environmental Geology: Conservation, Land-use Planning and Resource Management

By Peter T. Flawn. Harper and Row, New York. 1970. 313 p. $14.50.

Environmental geology is the study of the relationship between man and his geological habitat and more specifically is concerned with the problems man has in using the earth and the reaction of the earth to this use. Flawn does not attempt detailed coverage of this whole subject but chooses to consider primarily those aspects that are related to the urban environment or to the exploitation by the industrial society of the earth's mineral resources.

The subject is presented in a logical manner. The first two chapters present the case for the study of environmental geology and illustrate in considerable detail the range of natural and man-initiated geological problems, such as earthquakes, landslides and subsidence, with which man must deal. In chapter 3, the reader is introduced to the engineering properties of rocks and soils and to those measurements which are considered significant to civil engineering. Chapters 4, 5 and 6 which consider the earth's resources, man as a geological agent, and conservation and management constitute the most valuable part of this book.

In chapter 4 the author describes the cost and benefit to society which results from man's use of the earth's resources and considers the economics involved in the extraction of both high value materials, such as minerals, and low value earth resources, such as water and construction materials. In chapter 5 the geological consequences of urbanization and industrialization, especially the problem of wastes and waste disposal are considered in great detail. The economic and ecological thinking which has determined past and present methods of disposing of gaseous, liquid and solid wastes and the methods which are being used successfully and unsuccessfully by various cities and industries are discussed. In chapter 6 the conservation and management of resources is considered. The legal framework within which this can be performed in the United States is discussed and several examples of the weighing of alternatives are presented. Recommendations are made as to how the environmental geologist can contribute to the best use of the available resources by advocating the sequential use of certain land areas, as for example, to recommend that sand and gravel resources, which may be in short supply, be extracted before urban development makes them unavailable and requires the opening of pits at higher cost in more remote areas. This type of planning can benefit both the urban and conservation interests. This argument and indeed the whole tone of the book can be summed up by the following quote:

> "The purpose of this argument is to demonstrate to the planner and to the environmentalist that he cannot ignore the need of an industrial society to dig into the earth for materials and that however much he would like to preserve vast areas of wilderness, parks, and unscarred suburban and agricultural terrain, all of the pits, mines, and quarries cannot be relegated to someone else's area. Mineral resources are "where you find them". They must be planned around, not planned for".

In chapter 7, Flawn makes a plea for the geologist to become involved in the affairs of the community and to work at "selling" the advantages of environmental geological reports to planning agencies and engineering departments. In addition to selling the value of the report the geologist must stand ready to assist in its interpretation to the problems at hand.

In the final chapter the author provides the example of Austin, Texas, where the principles outlined in the book are currently being used in long range city planning. One of the books few weaknesses occurs at this point in that the foldout geologic map included with the book covers

only part of the city of Austin whereas the written description encompasses the whole city and its immediate surroundings. In addition this reader found difficulty in locating a number of features which were indicated as being on the map but which were located by street names which were either difficult to find or not identified on the map.

This book is a highly readable addition to the literature on the subject. It presents a pragmatic and realistic approach to the problem of balancing urban growth and conservation and should prove a useful reference book for introductory or intermediate level courses in urban planning and environmental geology. The book should also prove a useful reference on the subject for urban planners, elected and appointed officials and any persons involved in the process of extracting the earth's resources or who are concerned with the maintenance of a habitable environment.

The book has three Appendices. This reader feels that Appendix I and II, which present the Uniform Building Code of 1964, chapter 70, Excavating and Grading and the classification of rocks, respectively, add little to the value of the book. Appendix III, which is a glossary of terms commonly used in environmental geology, should prove very useful to those readers who are unfamiliar with geological terminology.

J. KENNETH TORRANCE

Department of Geography
Carleton University
Ottawa, Canada
K1S 5B6

Chemical Mutagens: Environmental Effects on Biological Systems

By L. Fishbein, W. G. Flamm and H. L. Falk. Academic Press, New York and London. 1970. xi + 364 p. $18.50.

Chemical Mutagens: Principles and Methods for Their Detection

Edited by A. Hollaender. Plenum Press, New York and London. 1971. Vol. 1, lxviii + 310 pp., Vol. 2, lxii + pp. 311 to 605. Set $30.00.

The human gene pool is the primary resource of mankind for all time. Mutations, which have been known as *sports* to plant and animal breeders for centuries, are sudden heritable changes within the genetic material that are passed on to succeeding generations. Of the mutations which occur, geneticists consider that only 1 out of every 1000 is likely to be beneficial to the species. Radiations are well known mutagenic agents and over the past few decades, precautions have been taken to protect man by restricting their use. But man is taking an ever increasing risk of mutagenic effects from the hidden chemical contaminants in his daily diet as the number of diverse chemicals used to increase food production — pesticides, antibiotics, hormones, tranquilizers, preservatives — continues to rise.

Information on chemical mutagenesis is scattered throughout the scientific literature and has accumulated to the level where radiation biology was about two decades ago. Therefore, the specialist will welcome these texts as ready references on all aspects of the subject — from the modes of action of known mutagens to the latest testing procedures. Not only geneticists, but toxicologists, pharmacologists, and various officials in regulatory capacities will be interested in these texts.

Chemical Mutagens: Environmental Effects on Biological Systems by Fishbein, Flamm and Falk consists of two major sections. The first is concerned with genetic principles which are necessary for the understanding of mutation. Chapters are devoted to the nature of the genetic material, mode of action of chemical mutagens, repair of genetic damage and systems for detection of mutants. In the latter chapter, microbial, *Drosophila*, mammalian, and cell culture systems are discussed, but no reference is made to any plant system. The second half of the book concerns specific chemical mutagens which are dealt with in considerable detail. Chapters are devoted to a tabular summary of chemical mutagens, alkylating agents and drugs, food additives, pesticides and miscellaneous mutagens.

The two volumed *Chemical Mutagens: Principles and Methods for their Detection*, edited by Hollaender, was sponsored by the Environmental Mutagen Society, and consists of a series of chapters by specialists. Volume 1 has chapters on the molecular mechanisms of mutation, methods used for DNA isolation and identification of chemical changes, the correlation between teratogenic, carcinogenic and chemical mutagens and the detection of mutations in virus, bacterial and yeast systems. Volume 2 continues with a discussion of the detection of mutations in *Neurospora, Aspergillus, Habrobracon, Drosophila,* plant root

tips, and cell culture systems. Chapters follow on the specific locus, dominant lethal and host-mediated assay test systems in mammals. A final chapter discusses the need for monitoring the human population for any increase in mutation rates. In the "Conclusion" by Hollaender, he points out that the cytogenetic, the dominant lethal and the host-mediated assay methods show the most promise in testing for mutagenicity in mammalian systems. At the same time he emphasizes that no single test is necessarily conclusive. Since some compounds may give negative results in the laboratory but still be mutagenic in man, efforts to detect mutations in man must be encouraged.

It may be truly said that these volumes represent a "guide and handbook to further study" and will be standard references for some time to come.

William F. Grant

Genetics Laboratory,
Macdonald Campus of
McGill University,
Ste. Anne de Bellevue,
Quebec, Canada.

Pollution and the Death of Man: The Christian View of Ecology

By Francis A. Schaeffer. Tyndale House Publishers, Wheaton, Ill. 1970. 125 p. $2.95.

This slim volume includes the author's moral and theological response to the environmental crisis, and reprints of two articles, the one by Lynn White Jr., The Historical Roots of our Ecological Crisis (Science 10 March, 1967), the other by Richard L. Means, Why Worry About Nature? (Saturday Review, Dec. 2, 1967). While Schaeffer accepts White's contention that the bad view of nature emanating from Christian theology is largely responsible for wastern man's rape of nature, he insists that the answer lies not in dismissing theology but in developing a theology of nature that is both true to the Bible and relevant to the present crisis.

Schaeffer attempts to hold together the pantheistic concept of the unity of man and nature, and the platonic concept of the qualitative difference between man and nature. He rejects Means' suggestion that pantheism by itself can provide the mobilizing force enabling men to change the desert into a garden. Bemoaning the fact that almost all the new theologians are drifting towards pantheism in company with the hippies, the Beatles and the pop prophets, he claims there is no place for a genuine dignity of man in the pantheistic East. Even St. Francis, whom White nominated as the patron saint of ecologists, falls short of providing for man a special role in nature that nothing else has.

Drawing from Biblical and Reformation theology, Schaeffer thinks Christians should reject both the view that there is no distinction between man and the other things, and the view that man is totally separated from all things. He argues that God is both personal and infinite. In respect to God's 'infinite' quality, man and the rest of nature are related through their common finiteness: the chasm is not between man and the rest of creation but between the Creator and all He has created. In this way the infinite quality of God implies the inter-relatedness of all finite creation. Turning to the personal quality of God, Schaeffer sees men as made in God's image and able to relate as persons to the personal side of God. Since the rest of nature is impersonal, and cannot relate to the personal God, a chasm exists not between man and God but between man and the rest of creation.

Schaeffer says we should look at a tree as a fellow creature made by God, but remembering man's special status in creation we should stop short of romanticizing about the tree. In practice this means we may cut down a tree to build a house, or make a fire to keep the family warm. But we should not use the axe unless the tree is necessary to maintain man's life and dignity. We have the right as Christians to kill an ant in our kitchen but when we meet an ant on the sidewalk we step over him. We are to honour what God has made up to the very highest level that we can honour it without sacrificing man.

According to Schaeffer the greed and haste which possess man, and are responsible for the exploitation of nature, cannot be exorcized by a society committed to technology, humanism, agnosticism, or atheism. The rift between man and nature will be healed when men, having first come into a right relationship with God, practice the Christian view of nature. Humanism is right in its cry for reconciliation between man and nature, but there is no evidence that humanism is capable of providing the mobilizing power to change the exploitive approach of man to one of healing. To ecologists and naturalists who are

operating without a Christian commitment, Schaeffer issues a summons characteristic of Christian evangelicals: if you want to lick pollution, repent and be saved.

The author has one foot in the exclusivist camp which radically separates man from nature, and the other foot in the inclusivist camp which sees man as simply a part of nature. Although he insists on the value of nature in itself and the value of nature for man's use, he fails to indicate how conflicts between these values ought to be resolved. Since Schaeffer's book leaves no room for Christians and humanists to tackle the environmental crisis with mutual respect for one another's mobilizing myths, to Christian naturalists the book will be embarrassing, to naturalists of other persuasions, amusing.

GERALD W. PAUL

Director of Program and United Church Chaplain
Iona College, University of Windsor
Windsor, Ontario

To the Arctic! The Story of Northern Explorers from Earliest Times to the Present

By Jeannette Mirsky. 3rd edition. The University of Chicago Press, Chicago. 1970. xxv + 334 + xvii pp. $10.00 (cloth), $3.45 (paper).

No one book could possibly tell all there is to know about the history of exploration of the northern polar regions. *To the Arctic!* which was first published in 1934 under the title of *To the North!* does however serve as an excellent introduction to northern history. The author puts in perspective the men who made that history, the men who described in sometimes the finest detail the country through which they travelled, and in some instances brought back to the civilized regions the specimens of plants, animals and rocks which form the basis of our knowledge of the natural history of the north, and for many of these explorers describes the trials and tribulations which faced them in their efforts to make new discoveries in an almost unknown land. The second edition, published in 1948, embodied some corrections and brought the northern story up to date. This third edition which differs from the second only in the inclusion of a new Preface by Vilhjalmur Stefansson, has been brought out at a time when interest in the north is at a new peak.

This is a book which anyone interested in almost any facet of the north will find of value. It will serve as a starting point from which the reader can advance to the selected titles found in the bibliography. It will be a useful library reference if for no other reason than the Appendix II 'List of Franklin Search Parties' and Appendix III 'Chronology of Northern Exploration'.

WILLIAM J. CODY

Plant Research Institute
Central Experimental Farm
Ottawa, Canada K1A 0C6

The Ecology of Running Waters

By H. B. N. Hynes. University of Toronto Press, Toronto. 1970. xxiv + 555 pp. $25.00.

This book is written by an eminent limnologist, teacher, and gentleman (and, I might add, dedicated to a person of equally great stature, Dr. David G. Frey). Professor Noel Hynes has given biologists a book long needed. However, to recommend the book merely because it is the only modern comprehensive book in stream ecology would be to do it a great injustice, for it is an exceedingly outstanding book. In it, is a thorough, easily read, review of the field. A book of this high calibre, yet readable by the non-specialist, would be highly desirable on lakes.

The book is a masterful synthesis of material. Professor Hynes has shown much adeptness in writing with such authority on the many specialized fields that pertain to running waters. The strength of the book lies partly in the ability of Professor Hynes to synthesize vast amounts of information (perhaps shown best in sections on adaptations and trophic relations). Reinterpretations and critical analyses of the literature are part of this work. The book includes virtually all major taxonomic groups of freshwater aquatic life. It is well illustrated. Most figures are original. Many organisms mentioned in the text and found in various parts of the world are figured, with special emphasis on showing adaptations to stream life.

The book consists of 23 chapters (one more than the 22 chapters indicated on the overleaf of my copy). The first three chapters deal with the physical-chemical characteristics of running

waters. Three chapters are concerned with plants and plankton. This is followed by eight chapters which discuss the benthic invertebrates. A review of the membership shows several families to be confined to stream life while even some species normally found only in the ocean (e.g., crabs) may occur in rivers. Fish are discussed in four chapters. The chapter on amphibians, reptiles, birds, and mammals is short because, like bacteria, we know relatively little of their place in the aquatic community. It is a weakness in the field and Professor Hynes points out areas where further research would be profitable. There is a chapter each on longitudinal zonation, special habitats (springs, etc.), and the ecosystem (including a short but excellent section on fish production). The book concludes with a chapter on the effects of man on watercourses. This chapter is short, I suspect, not because Professor Hynes felt our effects were few but because they are so poorly documented. May our effects decrease but our knowledge increase!

The bibliography is an excellent comprehensive review of the literature up to and including 1966. In all, there are over 1,500 listings, many from foreign journals. For each reference the location of the citation in the text is given and most text statements have the source given. A highly desirable feature is found in the index. After each genus a common name (if present) is given and after each listed taxonomic name the next higher taxon is given. This has the advantage of informing the non-specialist of just what a certain taxon is.

A few typographical errors exist but this is inevitable in such an extensive work. Of particular note, the taxonomic names *Catostomus* and Catostomidae are consistently misspelled in the text and index as *Catastomus* and Catastomidae (even in the bibliographic reference to the paper by Raney and Webster).

The Ecology of Running Waters is a must for the student of aquatic biology and highly desirable for every ecologist and naturalist. Unfortunately, the book sells in Canada for $25.00 while in Britain I understand it is almost half this price. Small wonder we read so little. Nevertheless, the book, like the author, can only be held in the highest esteem by those who know either.

JOSEPH S. NELSON

Department of Zoology,
The University of Alberta,
Edmonton, Alberta.

Pictorial Guide to the Birds of North America

Leonard Lee Rue III. Drawings by Juan C. Barberis, maps by Donald Pitcher, 140 photos by the author. Thomas Y. Crowell Company, New York; and Fitzhenry and Whiteside Limited, Toronto. 1970. xvi + 368 p. $15.75.

This is another in the long parade of bird books. As an illustrated guide to the field identification of North American birds, this one has serious limitations in that it deals with only 80-odd species. The author tells us that the species selected are either so common that everyone knows something about them or so rare that most people know nothing about them. Thus there are several hundred North American species that the book does not include. An extreme example of how this works out is found in the case of the wood warbler family Parulidae which contains some 57 species and is represented in this book by one species, the American Redstart.

The main contribution of the book seems to this reviewer to lie in the information and photographs contained in the species accounts. Each of these begins with a range map, a black and white sketch of the subject, and capsule accounts of field marks, size, habits, habitat, nest, eggs, food, and voice (all on one page) and this is followed by one to four pages of general information on the species concerned. These accounts are pleasingly written and interestingly illustrated by 140 photographs taken by the author.

Unfortunately the text is marred by errors and half-truths which could easily have been eliminated had the manuscript been properly checked by a competent ornithologist prior to publication. Following are some (not all) examples: Birds have only three toes (p. XIII); only two species of loons occur as far south as the United States (p. 1); the cormorant's *orange* (!) bill (p. 16); a bird in a photograph identified in the caption as an Evening Grosbeak is a Pine Grosbeak (p. 324); and the map of the range of the Eastern Bluebird extends the breeding range northward erroneously to northern Newfoundland and even southern Labrador!

A surprising statement is made that the eggs of the Robin are incubated by both parents. The author affirms that he has often watched as one bird relieves the other at the nest "with almost clockwork regularity". This is contrary to the experience of the many others, including ornithologists who have made extensive studies of the

breeding biology of this common bird, and who have observed that incubation of the eggs is by the female only.

The book closes with a useful 27-page appendix telling where to see birds, a 3-page bibliography, and an index.

W. EARL GODFREY

National Museum of Natural Sciences
Ottawa, Canada
K1A 0M8

The Best of Thoreau's Journals

Copyright 1967 by Carl Bode under the title *The Selected Journals of Henry David Thoreau.* Southern Illinois University Press, Carbondale and Edwardsville. 327 pp. $10.95. Available in Canada from Burns and MacEachern Ltd., Don Mills, Ont.

Thoreau's Journals, originally printed in 1906 as 14 volumes, have not received the attention given to his other writings. Carl Bode in this one volume selection gives the essence of the journals and for each year's selection provides useful headnotes on Thoreau's activities during the year and their influence on his writing.

Thoreau commenced his journals in 1837 at the age of 20 and continued to 1861 the year before his death at the age of 44. The selections by Bode clearly show how the formality and stiffness of his writing in the early years change very quickly to the unique and lucid style that marks him as one of the great writers of the Western world. It came as a surprise to see that Thoreau uses the word "thing" in a sense that many of us would consider modern: "Heroism, heroism is his word — his thing". This quotation is in one of the 1847 excerpts in which Thoreau is discussing Wordsworth.

Readers of Thoreau will welcome this comprehensive volume of the Journals as an addition to the better-known Walden, Cape Cod, and others. The volume includes a map of the Concord localities mentioned in the Journals. The majority of the selections will interest naturalists; others are of more general interest as they reflect Thoreau's love of freedom and his attempts to live a simple life in a profit-oriented society.

C. FRANKTON

2297 Fox Crescent
Ottawa, Canada
K2B 7K5

Common Wild Flowers of Minnesota

By Gerald B. Ownbey, Illustrated by Wilma Monserud. University of Minnesota Press, Minneapolis. 1971. 331 p., 304 figures, illustrated glossary. $9.75. Available in Canada from Copp Clark Publishing Company, Vancouver, Toronto, Montreal.

This guide to the common wild flowers of Minnesota is primarily a collection of drawings, a welcome addition to the library of anyone interested in natural history. I have noticed that the first response of any person, botanist or not, when confronted with an unknown plant is to examine a herbarium specimen or look for an illustration. Unfortunately, too many floras include few illustrations or none. The pen and ink drawings by Wilma Monserud are beautiful as well as technically accurate, making this new book useful to everyone.

The descriptions are in non-technical language, and unfamiliar terms may be found in the glossary. Most of the descriptions consist only of the flower color and the Minnesota distribution of the species, but the fine illustrations make additional descriptive text unnecessary in many cases. Although contrasting characters have been presented for several plants, for example the two common species in *Streptopus,* this generally means one is not illustrated. Because keys are not included, an occasional comparison of two or three similar species would have been helpful. A descriptive comment, or a few words to focus attention on an illustrated distinguishing character, such as the fibrous *vs.* membranous bulb coat in *Allium,* would also have been useful.

The plants are arranged alphabetically by family within the Monocotyledons and Dicotyledons. The index includes common and Latin names, and seems to be complete. The book, with its pale blue pages, is very attractive, and the drawings of each plant and brief descriptive text are on a single page. The superb drawings set this book above the usual popular regional flora, and I recommend it to all, professional or amateur.

JANET R. DUGLE

Environmental Control Section
Whiteshell Nuclear Research Establishment
Atomic Energy of Canada Limited
Pinawa, Manitoba

OTHER NEW TITLES

Advances in Ecological Research. Vol. 7. Cragg, J. B. (Ed.). Academic Press Inc., New York. 1971. 254 p. $10.00.

The Age of Mammals. Kurten, B. Weidenfeld and Nicolson, London. 1971. 250 p. £3.50.

Anatomy of the Monocotyledons. Vol. 5, Cyperaceae. Bibliographical note by Mary Gregory. Clarendon Press, London; Oxford University Press, New York and Toronto. 1971. 598 p. $29.00.

Animals in Migration. Orr, R. T. Macmillan and Co., New York. 1970. 303 p. $21.50.

Animals of the Arctic: The Ecology of the Far North. Stonehouse, B. Holt, Rinehart and Winston Ltd., New York. 1971. 172 p. $10.95. Profusely illustrated with 200 colour photographs, maps and charts, the book deals with polar and subpolar plants and animals, the changing climate, and the sea bed fauna, sea birds, and the tundra challenged by man.

Architecture in a Crowded World: Vision and Reality in Planning. Brett, Lionel. Schocken Books, New York. 1971. 185 p. $6.50.

***Army Ants: A Study in Social Organization.** Schneirla, T. C. (Ed. H. R. Topoff). W. H. Freeman and Co., San Francisco. 1971. 349 p. $12.00.

Aspects of the Biology of Symbiosis. Cheng, Thomas C. (Ed.). University Park Press. 1971. 327 p. $14.50. Complete proceedings of the AAAS symposium concerned with the interdisciplinary study of commensalism, mutualism, and research on parasites of medical importance.

Atlantic Reef Corals: A Handbook of the Common Reef and Shallowater Corals of Bermuda, the Bahamas, Florida, the West Indies and Brazil. Smith, F. G. W. University of Miami Press, Miami. 1971. 164 p. $6.95. Simple guide to rapid identification for amateur and scientist.

Biochemical Responses to Environmental Stress. Bernstein, I. A. (Ed.). Plenum Press, New York. 1970. 153 p. $7.95.

***Biochemical Toxicology of Insecticides.** O'Brien, R. D., and I. Yamamoto. Academic Press, New York. 1970. 218 p. $8.50.

Biological Studies of the English Lakes. Macan, T. T. American Elsevier Co., New York. 1970. 260 p. $13.00.

Biology in the World of the Future. Hellman, H. M. Evans Co., New York. 1971. 188 p. $4.95.

Can Man Care for the Earth? Heiss, R. L., and N. F. McInnis. Abingdon Press, Nashville, Tenn. 1971. 127 p. $1.95. Attempts to show that ecological concern is an important part of the Christian faith.

Challenge to Survival: A Philosophy of Evolution. Williams, L. Andre Deutsch Co., London. 1971. 316 p. £3.50.

Chemical Analyses of Plant Tissues from the Hubbard Brook Ecosystem in New Hampshire. Likens, G. E., and F. H. Bormann. Yale University School of Forestry Bull. No. 70. 1970. 25 p. $2.50. Yale University, New Haven, Conn.

Chemical Evolution and the Origin of Life. Buvet, R., and C. Ponnamperuma (Ed.). North-Holland Pub. Co., Amsterdam; American Elsevier, New York. 1971. 572 p. $23.50. Molecular Evolution Vol. 1.

***The Classification, Evolution and Dispersal of the Winter Stonefly Genus** *Allocapnia*. Ross, H. H., and W. E. Ricker. Illinois Biological Monographs No. 45. University of Illinois Press, Urbana, Ill. 1971. 166 p. $8.95.

The Closing Circle. Commoner, Barry. Alfred Knopf Co., New York. 1971. $8.25. The reason for today's pollution problems lie in the change in technology since W.W. II. We use the ecosphere to produce wealth which in turn is destructive to the ecosphere.

Coastal Zone Resource Management. Hite, J. C., and J. M. Stepp (Eds.). Prager Publishers, New York. 1971. 169 p. $13.50.

The Concorde Affair: From Drawing Board to Actuality. Davis, J. Henry Regnery Co., Chicago. 1970. 238 p. $5.95.

A Critical Review of the Techniques for Testing Insecticides. Busvine, James R. Commonwealth Agricultural Bureaux, Slough, England. 1971. 346 p. $13.00. 2nd edition.

Dams and Other Disasters: A Century of the Army Corps of Engineers in Civil Works. Morgan, A. E. Porter Sargent Co., New York. 1971. 448 p. $7.50. A critical, annotated survey, documents the inadequacies of the Army Corp's past pattern of performance in public works and environmental protection projects.

The Deadly Feast of Life. Carr, D. E. Doubleday and Co., New York. 1971. 269 p. $7.95. An examination of the food chain. How species eat and what; how they adapt; why some rise, decline and become extinct; the poison which some plants and animals have evolved to protect themselves, and the poisons man has developed.

Effects of Metals on Cells, Subcellular Elements and Macromolecules. Maniloff, J., J. R. Coleman, and M. W. Miller. Charles C. Thomas Co., Springfield, Ill. 1970. 397 p. $20.50. Proceedings of the Second Rochester Conference on Toxicity.

***Environment and Man.** Wagner, R. H. W. W. Norton and Co., New York. 1971. 491 p. $7.50.

Environmental Quality and Safety: Global Aspects of Chemistry, Toxicology and Technology as Applied to the Environment. Vol. 1. Coulston F., and F. Korte (Ed.). Academic Press, New York. 1971. 300 p.

Everglades. Caulfield, Patricia *et al.* Sierra Club/Ballantine Books, New York. 1971. 142 p. $3.95.

The Everglades Today: Endangered Wilderness. Sand, George X. Four Winds Press. 1971. 191 p. $5.95. A readable discussion of man's threat to the land, and to the plants and creatures that inhabit it.

Experimental Embryology of Marine and Fresh-water Invertebrates. Reverberi, G. (Ed.). American Elsevier, New York. 1971. 587 p. $32.00.

The Fauna of India and Adjacent Countries. Roonwal, M. L. (Ed.). **Pisces (2nd edition). Vol. 1, Elasmo-**

branchii and Holocephali. Misra, K. S. Issued by the Zoological Survey of India, Calcutta, and published by The Manager of Publications, Delhi. Government of India Press, Faridabad. 1969. 276 p. 116s 8d (ca. $18.00). Illustrated with line drawings. It will be indispensable to anyone interested in the Indian piscifauna; the first edition of "Fishes of India" by Day in 1889 is somewhat out of date.

Geomorphology of Cold Environments. Tricart, J. Macmillan and Co., London and Toronto. 1970. 320 p. $12.95.

High Arctic: An expedition to the Unspoiled North. Sutton, G. M. Erikson Co. 1971. 134 p. $12.95. Describes the experiences of the ornithologist-painter in the desolate landscapes of the far north, documenting brant, jaegers, snow geese, muskoxen, lemmings, elders and ptarmigan.

Hormonal and Attractant Pesticide Technology, 1971. Meltzer, Yale L. Noyes Data Corp., Park Ridge, N.J. 1971. 282 p. $35.00.

*__How to Know the Marine Isopod Crustaceans.__ Schultz, George A. Wm. C. Brown Co., Dubuque, Iowa. 1970. 359 p. $5.50 cloth, $4.50 paper.

How to Manage Your Company Ecologically. Goldstein, Jerome (Ed.). Distributed by David McKay Co., New York for Rodale Press. 1971. 119 p. $1.95.

Impingement of Man on the Oceans. Hood, D. W. (Ed.). John Wiley & Sons Ltd., Toronto, London, New York. 1971. 750 p. £11.75. Status of current knowledge of ocean pollution; background oceanographic information is given.

Introduction to Quantitative Paleoecology. Reyment, R. A. American Elsevier, New York. 1971. 226 p. $16.75.

Introduction to the Study of Animal Populations. Andrewartha, H. G. University of Chicago Press, Chicago. 1971. 284 p. $7.50. 2nd ed.

Insects and How They Function. Callahan, Philip S. Holiday House. 1971. 191 p. $4.95. Explains how the organs and bodies of insects are built, how their structures function and how they sense their environment. A number of experiments are included.

The Kodiak Island Refugium: Its Geology, Flora, and History. Karlstrom, T. N. V., and G. E. Ball (Eds.). The Ryerson Press, Toronto (McGraw-Hill Co.). 1969. 262 p. $10.00. Published for the Boreal Institute, University of Alberta, Edmonton.

The Last Resource: Man's Exploration of the Oceans. Loftas, T. Henry Regnery Co., Chicago. 1970. 276 p. $6.50.

The Last of the Ruling Reptiles: Alligators, Crocodiles, and their Kin. Neill, W. T. Columbia University Press, New York. 1971. 486 p. $15.95.

Manic 5: The Building of the Daniel Johnson Dam. Rethi, Lili, and W. W. Jacobus Jr. Doubleday and Co., New York and Toronto. 1971. 165 p. $9.95. Describes the organization of a monumental engineering feat that involved 3,500 Canadian workers, and "conveys the excitement of construction, dramatically documented in the drawings."

Mercury in the Environment: A Toxicological and Epidemiological Appraisal. Friberg, L. T., and J. J. Vostal. Chemical Rubber Co. Press, Cleveland, Ohio. 1972. 300 p. $33.00.

Of Microbes and Life. Monod, Jaques, and E. Borek (Eds.). Columbia University Press, New York. 1971. 312 p. $12.50.

The Natural History of the African Elephant. Sikes, Sylvia K. American Elsevier, New York. 1971. 397 p. $30.00.

The New Face of Science. Hoyle, Fred. W. W. Norton Co., New York. 1971. 132 p. $6.95. Thoughtful essays on the role of science as a vital force that can help change outdated attitudes. Looks at the world from the viewpoint of a physicist and astronomer.

*__Paleozoic Fishes.__ Moy-Thomas, J. A., and R. S. Miles. W. B. Saunders Co., Philadelphia and Toronto. 1971. 259 p. $13.15. 2nd edition.

Pesticides in the Environment. White-Stevens, R. (Ed.). Marcel Dekker Co., New York. 971. Vol. 1, Pt. 1 270 p. $23.50; Pt. 2 629 p. $28.50. Properties, functions, assays, toxicology, and resistance.

Plant Speciation. Grant, Verne. Columbia University Press, New York and London. 1971. 432 p. £7.25.

Pollution, Profits and Progress. Schroeder, Henry A. Stephen Greene Press, New York. 1971. 137 p. $4.95. The author, an expert on the biological effects of trace elements, discusses scientific units of minerals, some of their known contributions to optimal health, levels of toxicity, and related issues.

Prehistoric Agriculture. Streuver, Stuart (Ed.). Natural History Press, Garden City, N.Y. 1971. 733 p. $8.95 cloth, $4.95 paper. Focuses on the emergence of agriculture, the early domestication of plants and animals in different parts of the world.

Public Affairs. Snow, C. P. Macmillan and Co., London. 1971. 224 p. $9.95. Reflections on the "Two Cultures", science and government and the moral unneutrality of science.

Reason and Experience: The Representation of Natural Order in the Work of Carl Von Linné. Larson, James L. University of California Press, Berkely. 1971. 172 p. $7.50. Examines the nature and extent of the connection between the logical forms and natural forms implicit in Linné's systemic structure of nature.

Remote Sensing in Ecology. Johnson, P. L. (Ed.). University of Georgia Press, Athens, Ga. 1969. 244 p. $8.00.

Reservoir Fisheries and Limology. Hall, G. E. (Ed.). American Fisheries Society Special Publication No. 8. A.F.S., Washington, D.C. 1971. 514 p. $14.00.

The Role of Nitrogen in Grassland Productivity. Whitehead, D. C. The Grassland Research Institute, Hurley, Berkshire, U. K. 1970. 202 p. $5.90.

Savage Luxury: The Slaughter of the Baby Seals. Davies, Brian. Taplinger Publishing Co., New York. 1971. 214 p. $6.50.

A Science of Social Issues. Stewart, Bruce. Scarecrow Press, Metuchen, N.J. 1971. 328 p. $7.50.

***Scientific Knowledge and Its Social Problems.** Ravetz, J. R. Clarendon Press, London; Oxford University Press, Don Mills, Ont. 1971. 450 p. $12.50.
Sea and Earth. The Life of Rachael Carson. Sterling, P. Thomas Y. Crowell Co., New York. 1970. 213 p. $4.50.
Trace Elements in Human and Animal Nutrition. Underwood, E. J. Academic Press, New York. 500 p. 3rd ed.
Wild Flowers of the United States. Vol. 5, Parts 1 and 2. The Northwestern States: Washington and Oregon West of the Cascade Range and California Southward to the Deserts. Rickett, Harold W. McGraw-Hill Co., New York. 1971. 666 p. $57.50. A comprehensive, scientifically accurate work for the serious amateur and student, covers some 3,000 species from a wide range of climatic environments.
The World of the Gull. Costello, David F. J. B. Lippincott Co., Philadelphia. 1971. 157 p. $5.95. Habits and life cycles of various gull species; the habitats utilized.
World Soils. Bridges, E. M. Cambridge University Press, New York. 1970. 89 p. $3.95. 32 colour plates.
Science Council of Canada Publications. Available from Information Canada Bookstores. Variously paged and priced.

Reports

No. 1 — A Space Program for Canada
2 — The Proposal for an Intense Neutron Generator
3 — A Major Program of Water Resources Research in Canada
4 — Towards a National Science Policy for Canada
5 — University Research and the Federal Government
6 — A Policy for Scientific and Technical Information Dissemination
7 — Earth Sciences Serving the Nation — Recommendations
8 — Seeing the Forest and Trees (A Report on Forest Resources Research)
9 — This Land is Their Land (A Report on Fisheries and Wildlife Research in Canada)
10 — Canada, Science and the Oceans
11 — A Canadian STOL Air Transport System — A Major Program
12 — Two Blades of Grass — The Challenge Facing Agriculture
13 — A Trans-Canada Computer Communications Network: Phase I
14 — Cities for Tomorrow: Some Applications of Science and Technology to Urban Development
15 — Innovation in a Cold Climate

Special Studies

No. 1 — Upper Atmosphere and Space Program for Canada
2 — Physics in Canada
3 — Psychology in Canada
4 — The Proposal for an Intense Neutron Generator
5 — Water Resources Research in Canada
6 — Background Studies in Science Policy: Projections of R & D Manpower and Expenditure
7 — The Role of the Federal Government in Support of Research in Canadian Universities
8 — Scientific and Technical Information in Canada Part I
Part II — Chapter 1 (Government Departments and Agencies)
Chapter 2 (Industry)
Chapter 3 (Universities)
Chapter 4 (International Agencies & Foreign Countries)
Chapter 5 (Techniques and Sources)
Chapter 6 (Libraries)
Chapter 7 (Economics)
9 — Chemistry and Chemical Engineering: A Survey of Research and Development in Canada
10 — Agricultural Science in Canada
11 — Background to Invention
12 — Aeronautics — Highway to the Future
13 — Earth Sciences Serving the Nation
14 — Forest Resources Research in Canada
15 — Scientific Activities in Fisheries & Wildlife Resources
16 — Ad Mare: Canada Looks to the Sea
17 — Survey of Canadian Activity in Transportation R &D
18 — From Formalin to Fortran: Basic Biology in Canada
19 — Research Councils in the Provinces: A Canadian Resource
20 — Prospects for Scientists and Engineers in Canada
21 — Basic Research

Swedish Natural Science Research Council Publications

No. 4 — Methylmercury. Lofroth, Goran. 1969. 39 p. $2.00.
5 — Metals and Ecology. 1969. 68 p. $2.00.
6 — Gasoline Containing Lead. Danielson, Lennart. 1970.
7 — Aspects on the Toxicity of Cadmium and its Compounds. Nilsson, R. 1970. 58 p. $2.00.
10 — Global Environmental Monitoring System. Lundholm, B., and S. Swensson. 1970. 64 p. $2.00.

Available from Redaktionstjansten, Natural Science Research Council, Box 23136, S-104 35 Stockholm, Sweden.

*Assigned for Review.

Report of Council to the Ninety-third Annual Meeting of The Ottawa Field-Naturalists' Club December 2, 1971

During the past year, eight meetings of Council were held in Centennial Tower and the Victoria Memorial Building: January 7, February 17, April 1, May 20, June 10, September 15, October 13, and November 18, 1971. The Club's business was conducted in the usual orderly manner.

Appointments for 1971 were made as follows:

Editor, The Canadian Field-Naturalist	T. Mosquin
Business Manager, The Canadian Field-Naturalist	W. J. Cody
Chairman, Publications Committee	J. H. Ginns
Editor, Trail & Landscape	Anne Hanes
Chairmen, Macoun Field Club Committee	I. M. Brodo and J. A. Fournier
Chairman, Excursions and Lectures Committee	E. C. D. Todd
Chairman, Natural Areas Committee	H. N. MacKenzie
Chairman, Finance Committee	G. J. Wasteneys
Chairman, F.O.N. Affairs Committee	Elva MacKenzie
Chairman, Education Committee	J. A. Fournier
Chairman, Membership Committee	G. J. Wasteneys
Chairman, Bird Census Committee	F. M. Brigham
Chairman, Public Relations Committee	J. D. Lafontaine

Report of the Publications Committee

Since the last Annual Meeting, 5 numbers of The Canadian Field-Naturalist have been published. These include Volume 84, Numbers 3 (July-September, 1970, containing 125 pages), and 4 (October-December, 1970, containing 101 pages); and also Volume 85, Numbers 1 (January-March, 1971, containing 97 pages), 2 (April-June, 1971, containing 104 pages), and 3 (July-September, 1971, containing 79 pages).

The number of items in six major subject areas is as follows:

	Articles	Notes	Reviews
Botany	5	3	9
Herpetology	0	4	4
Ichthyology	5	3	5
Mammalogy	8	9	3
Ornithology	18	29	2
Miscellaneous	1	5	13

Volume 85, Number 4 should be mailed to subscribers in December, 1971.

Of particular interest in these issues is the number (Vol. 84, No. 3) dedicated to the survival of the Peregrine Falcon and an article (Vol. 84, No. 4) discussing the new developments proposed for Canada's Rocky Mountain National Parks.

The Conservation Committee of the Canadian National Sportsmen's show again generously supported the publication of the Canadian Field-Naturalist through a grant of $500.

Expenditures for the Canadian Field-Naturalist are recorded in the financial statement of the Club.

Report of Excursions and Lectures Committee

During the year there were 41 excursions, 3 formal lectures, 4 discussion groups, one general meeting devoted to a photographic competition and showing of members' slides, and the annual meeting. There was a reduction in the number of formal lectures and in their place informal discussion groups were organized on specific topics on birds and flowers followed by refreshments. This informal form of meeting seems preferable to the majority of the local membership and similar meetings are being prepared for the coming year.

There were 25 ornithological, 3 botanical, 1 entomological, 1 astronomical, 1 geological, and 8 general interest excursions, and one excursion for removing trash from the Gatineau Park. Attendance at these excursions averaged about 25 persons. A spring weekend trip to the Bruce Peninsula had to be cancelled because of lack of sup-

port but 14 members and their families spent Labour Day weekend in Le Parc de la Verendrye. No annual dinner was held this year owing to the Club's participation in the annual meetings in Ottawa of the Federation of Ontario Naturalists and the Canadian Nature Federation. Four excursions were arranged for these meetings.

Report of the Editorial Committee for Trail & Landscape

Trail & Landscape has completed the fifth year of publication. In each year five issues have been sent to all local members, subscribers and a few out-of-town members, and to various local institutions. Every issue has been received on time, through the devoted efforts of our volunteer production staff.

The mailing list of Volume One #1 had 210 names; the final issue of Volume Five went out to 772 addresses. The Club's phenomenal growth in this five-year period has created substantial problems for those planning club activities and administering club affairs. Trail & Landscape however, has benefited from the greater public interest in the natural environment which this growth represents. Our increased readership has been matched by wider contacts among contributors of natural history articles and features. Club members themselves continue to provide the greater part of our material, which emphasizes the natural history of the Ottawa area, local conservation, and the affairs of the Ottawa Field-Naturalists' Club.

This year, the Editors of T & L initiated a survey of the local membership. With the help of others from the Membership and Education Committees, a questionnaire was designed to sound out the opinions of club members on the direction the Club should take and the sorts of programs they would like. It also served to discover new resources in leadership, skills, volunteer help, and contributors to T & L. The questionnaire form was mailed with the September issue of T & L. The results of this survey are reported separately.

Report of the Macoun Field Club Committee

1. *Membership* — The Club began the year with full rosters; 35 members for each the Juniors, Intermediates, and the Seniors. By May, the numbers had narrowed to 35 Juniors, 26 Intermediates, and 34 Seniors. At the end of the year the Juniors had a waiting list of about 10 applicants. The 1971-72 season has started with full memberships and waiting lists for both the Juniors and the Seniors.

2. *Activities* — The Junior and intermediate groups had similar, but not identical, programmes on Saturday mornings. The programmes consisted of natural history games, films, talks by invited speakers, and the very important 'observation periods' when the members describe and discuss things they have seen, done or read about in natural history.

   The Seniors had a full programme of 12 invited speakers, most of them scientists who spoke about their own research. The members also gave some talks of their own, viewed some films, and held discussions of their own. During April they held their third annual symposium; the topic this year was 'Overwintering'. The symposium lasted four meetings; nine members contributed papers that they prepared and read themselves.

   Field trips were held by all groups. The Saturday morning groups went fossil hunting, bird watching, and visited the Department of Lands and Forests' tree nursery at Kemptville. The all-day spring field trip was held in the Fortune Lake area this year.

   The Seniors had groups going to the Nature Study Area in Bells Corners almost every weekend for birding, plant hunting or just walking. During the winter months they had to use snowshoes or skis. At the end of August they embarked on a new Macoun Club adventure — canoeing. Twenty members and five leaders took an eight day trip into the wilds of the Algonquin Provincial Park (the Canoe Lake — Trout Lake area). Each participant planned his or her daily activities; there was no pre-planned programme for the group as a whole. Dawn and dusk canoe trips to observe birds and wildlife and for fishing were the most popular, while hikes, collecting trips, and swimming took up the rest of the day when we were not occupied with moving camp and carrying over the 12 portages that dotted the 40-mile route. The trip was a monumental success.

3. *Publications* — The Newsletter was published each month and contained notes about coming meetings, articles about new and old books, and of course 'News' that was of inter-

est to the members. The Club's 'Little Bear' magazine was the largest issue the Club has ever produced and contained 96 pages of articles, stories, and drawings contributed by the members. A special section was added that contained the Senior symposium papers another section summarized all our knowledge of the Bells Corners Study Area.

4. *Facilities* — The Club continued to use Room 359 in the Victoria Memorial Building of the National Museums. As this report goes to press, however, there is some doubt about the continued use of these quarters during the remaining renovation period of the Museums. There is no doubt that alternative quarters will be found — just what they will be still rests in the laps of the fates at this time. The library did not grow spectacularly this year, although several new conservation-oriented books were purchased.

5. *Chairmanship* — In June, 1971, I. Brodo retired from the chairmanship after a tenure of 5 years, but continues as advisor for the Senior Group. Mr. J. A. Fournier, of the Education Division of the National Museum of Natural Sciences, assumed the position in his stead. The assistant chairman, Mr. Michael J. Shchepanek also retired after six years. Members of the Senior Group will assist on Saturday mornings until a new assistant is appointed.

Report of the Natural Areas Committee

The Committee met three times during the year and achieved the following results:

1. On April 30th the chairman submitted a brief to the Planning Committee of the Regional Municipality of Ottawa-Carleton. This brief, which was favourably received, outlines the Club's views on the proposed Official Plan for the Regional Municipality. Next year's chairman of this Committee should be on the watch for further developments in this area.

2. The committee responded to a request from the Management Forester (Mr. M. Schaefer), Ontario Department of Lands and Forests, for information on the forest management lands in the Bells Corners area. Dr. Brodo provided extensive information on the Macoun Club study areas, based on work of the Club members and their leaders. Mr. Derek Munro also provided useful data pertaining to the Jack Pine Trail area. The committee gratefully acknowledges this support.

3. The natural areas inventory forms are not being used by Club members. Committee members agree that one more year will indicate if the idea can be successfully applied or not.

   It is proposed that next year's chairman of the Excursions and Lectures committee plan some outings to the areas in the Ottawa-Carleton Regional Municipality which the Club has proposed as Nature Reserves. A map can be made available for planning purposes.

4. Negotiations are presently under-way to arrange for the use of a privately-owned area in Lanark County. The owner has indicated willingness to permit access by club members in return for work on nature trails, ski trails and other similar projects. Field trips will be arranged if a satisfactory agreement can be reached. Bill Holland has played a leading role in these discussions.

Report of the Federation of Ontario Naturalists Affairs Committee

The Ottawa Field-Naturalists' Club played host to the 39th annual meeting of the Federation of Ontario Naturalists April 23rd, 24th and 25th. Your F.O.N. Affairs Committee co-ordinated this project. We held eight formal and many informal meetings in this connection. The club members' response was tremendous — the committee had no difficulty in recruiting help.

I would like at this time to personally thank all the members of the committee as well as the many, many, club members who gave so generously of their time and talents to make this meeting such a success.

In the next issue of Trail and Landscape we plan to begin an F.O.N. activities and tell you some of the things the F.O.N. is doing on our behalf regarding pollution and other environmental issues.

Report of the Finance Committee

The Finance Committee is one of three Standing Committees established under Article 11 of the Constitution.

A second Committee, the Reserve Fund Committee is established by By Law No. 4 to "serve in an advisory capacity to the Council in matters concerning the investment of the Reserve Fund". The Finance Committee appears to have always provided the functions of the Reserve Fund Committee.

The Reserve Fund

The Reserve Fund is described under Article 8 of the Constitution as follows:

> "This fund shall contain moneys invested so as to maximize long-term capital growth while maintaining sufficient flexibility to provide money on short notice for special requirements as needed".

The Reserve Fund presently comprises approximately $12,400 made up as follows:

(1) $10,700 in Canada Savings Bond Series S24 1969/70 maturing in 1978 and yielding at maturity 8% plus compound interest on retained earned interest amounts.

(2) Thirty-five (35) shares of Bell Telephone Common Stock, 2 shares of Preferred and 2 shares of Microsystems International, a related company. Ownership of the Preferred shares has grown out of the creation of "Rights" for the Common Shares.

The Committee recommends that no change should be made in the investments until such time as the Bell Telephone Stock returns to the price at which it was purchased (approximately $46.00 per share). At that time it should be sold and the proceeds invested in Canada Savings Bonds which are a more appropriate form of investment for the Club. In illustration it can be seen that Canada Savings Bonds will earn 8% plus compound interest, if held to maturity in 1978 and can be sold at any time at face value.

The wisdom of a previous Finance Committee recommending the purchase of the 1969/70 Series is highly commended as this is by far the most profitable Series ever created.

In contrast, the Bell Telephone Stock currently earns 5.7% on the original investment. Details on the actual amounts will be found in the Treasurer's Report.

Although the Finance Committee has not met during the year, as a body, its members have participated in several quite extensive studies requested by the Council on the work-load of the Treasurer and on the overall revenue and expense of the Club with a view to a recommendation concerning membership fees.

In submitting this report the Finance Committee is concerned to draw to the attention of the membership the circumstance that the level of public expenditure in 1970 has been in excess of current revenue. While this has been caused, to some extent, by non-recurring expenditures it is apparent that serious consideration should be given by the new Council to additional sources of revenue which may include a necessity to increase membership fees.

It is strongly recommended that the Finance Committee should be actively concerned in providing advice and recommendations to the Council, in association with the Treasurer, on all factors related to the revenue and expenditures of the club. This would appear to be the function envisaged for this Committee when the constitution was established.

The growing size of the club and the complexity of its operation make it difficult for the members of Council to fully comprehend the day-to-day financial situation. It is too heavy a burden for the Treasurer to be solely responsible for advising Council on financial aspects and it is our view that he should have available to him the advice, consultation and co-operation of an informed Committee.

Report of Membership Committee

At the end of October membership in the club was 1138, an increase of 110 over the previous year. The composition of membership was as follows: With annual fee shown in brackets — Individual ($5.00) 947, an increase of 74; Family ($7.00) two votes, 171 an increase of 30; Sustaining ($25.00) 1; life fee ($200.00) 9, no change; Honorary (no fee) 11, an increase of 6. About half individual members and all family members are currently residents of the Ottawa area. For other comparisons see the detailed table which is provided at the end of this report.

All members receive the club's quarterly publication, The Canadian Field-Naturalist (one copy per family membership). In addition the club publication Trail and Landscape (5 issues per year) is received by all members in The Ottawa area and such other members as request this service.

At the commencement of the club year, there were a total of five Honorary members comprising Herbert Groh, Dr. H. F. Lewis, Stuart Criddle, Hoyes Lloyd and Wilmot Lloyd. Following an extensive review by Louella Howden & Messrs. W. J. Cody & W. K. W. Baldwin, the Committee recommended the election of a further six members which was unanimously approved by Council. The following were elected:

Father F. E. Banim, Prof. A. F. Coventry, Rowley Frith, Dr. A. E. Porsild, M. Y. Williams, Dr. C. M. Sternberg.

In addition to members there were a total of 498 institutional subscribers to The Canadian Field-Naturalist (Annual subscription $10.00) an increase of 37 over the previous year.

A table illustrating comparative figures for past year and location of subscribers during 1971 is found below.

	1969	1970	1971	Increase in '71
Individual Members				
Ottawa	337	357	446	89
Rest of Canada			396	
U.S.A.			92	
Foreign			13	
Total Individual	723	873	947	74
Family Members (Ottawa)	78	141	171	30
Life Members	9	9	9	
Honorary Members	6	5	11	6
	816	1028	1138	110
Institutional Subscribers to C.F.N.				
Ottawa			29	
Rest of Canada			200	
U.S.A.			236	
Foreign			33	
TOTAL:	418	461	498	37

Report of the Bird Census Committee

The Bird Census Committee was particularly active this year organizing the following activities:

The Christmas Bird Count, under the supervision of Dr. R. Foxall, was held on December 27, 1970. Although a record snowfall hampered the movements of the participants, the group did manage 64 species including 1 Red-throated Loon, 1 White-winged Scoter, 2 Common Snipes which were all new to the count.

On the weekend of April 3rd to 5th, the members of the Committee initiated Ottawa's first organized owl census. The group was blessed with good weather and an amazing list of owls including 8 species and 106 individuals, one of which was a Great Gray Owl.

The Spring Roundup was held on May 23, 1971. Thirty observers in fifteen independent parties recorded 171 species for the day. Highlights of the survey included 1 Glossy Ibis, second record for Ottawa; 6 Gadwalls at Black Bay; one family of 5 Red-headed Woodpeckers; and 6 Ravens including one nest with two young.

A similar survey was held on Sunday, September 7th which resulted in 182 species the most ever recorded in the Ottawa District in one day. Oustanding finds included 250 Golden Plovers, 3 Upland Plovers, 2 Stilt Sandpipers, 1 Buff-breasted Sandpiper, 2 Northern Phalaropes, 1 Yellow-billed Cuckoo, 6 Saw-whet Owls, 1 Carolina Wren, 6 Mocking birds, 1 Cardinal, 1 Le Conte's Sparrow and 10 Clay-colored Sparrows.

Perhaps the committee's most significant contribution to the public was the completion of the new Ottawa Check-list. In addition to bringing up to date the recorded species since the last Check-list in 1963, status was determined for the seasons. All unusual sight records and breeding records were also indicated.

Minutes of the Ninety-second Annual Meeting of The Ottawa Field-Naturalists' Club

The 92nd annual meeting of the Ottawa Field-Naturalists' Club was held in the auditorium of the National Library on Tuesday, December 8, 1970. The meeting was called to order at 8:10 p.m. by the President, Dr. Theodore Mosquin. Thirty-seven persons were in attendance.

The Secretary distributed copies of the minutes of the 91st annual meeting and moved that they be adopted. Trevor Cole seconded the motion and it carried.

The Statement of Financial Standing was presented by the Treasurer, Mr. F. M. Brigham. Its adoption was moved by Mr. Brigham, seconded by Mr. H. N. MacKenzie and carried.

The Secretary distributed copies of the annual report which he had compiled from reports of the committee chairmen. The following comments were made:

— Dr. Dore congratulated Mr. G. H. McGee on the bird column being written in the Clarion and the Guardian.

— Mr. MacKenzie said that a new bird check list would be available in 1971.

— Mr. H. N. MacKenzie urged members to fill out the inventory form being distributed by the Natural Areas Committee.

— Mrs. Elva MacKenzie called attention to the F.O.N. annual meeting being held in April 1971 and asked members to volunteer their help.

— The Secretary moved that the annual report be accepted. Mr. W. J. Cody seconded the motion and it carried.

The President, Dr. Theodore Mosquin reviewed the year's accomplishments. He mentioned that the membership had increased by 20 per cent. He said that there had been an overwhelming response in favour of the new format for The Canadian Field-Naturalist. Increasing costs, however, indicated that it might not be possible to support the publication from membership fees. He called attention to the success of Trail & Landscape, which he attributed to the editor, Mrs. Anne Hanes. He congratulated the Excursions and Lectures Committee for their work under Dr. Ewen Todd, and mentioned that Dr. Todd would welcome any help the members could give him. Other items mentioned by Dr. Mosquin were the calendar being sold by the club, the fact that the NCC was going to reprint the birds and geology leaflet, the photo contest, the interest of the local chapter, National and Provincial Parks Association in Gatineau Park and the fact that the new council would have to decide on our role, the brief to the Regional Municipality of Ottawa-Carleton on natural areas, the International Youth Federation meeting in July and the F.O.N. meeting in April. Mr. Gerald McKeating, Executive Director of the Federation of Ontario Naturalists was introduced and elaborated on the arrangements made for the F.O.N. meeting.

Dr. Ewen Todd presented the list of officers and council members. To the list he added the name of Dr. Allan Reddoch. Dr. Todd moved that nominations be closed. Elva MacKenzie seconded the motion and the slate was declared elected.

It was moved by W. J. Cody, seconded by T. J. Cole that Geoffrey Wasteneys and Tony Erskine serve as auditors for 1971. Carried.

The Resolutions Committee headed by Dr. J. H. Ginns and composed of Arnet Sheppard and Brian Morin presented the following resolutions for the incoming council to consider:

1. That legislation similar to that governing the national parks be enacted to protect Gatineau Park;
2. That a national park be established on the north shore of Lake Superior;
3. That an environmental bill of rights be established; and
4. That lumbering be prohibited in Quetico Park.

With respect to Resolution No. 4, Sheila Thomson said that it should be expanded to include all Ontario Provincial Parks, with specific reference to Quetico Park. Eighteen were in favour of this and 19 voted that it should be confined to Quetico Park.

In other new business Mr. Wasteneys called attention to the fact that the reduction in the number of small farms in Canada was detrimental to our wildlife populations.

At the conclusion of the business meeting, Brian Morin showed a collection of slides from the National Collection of Nature Photographs.

The meeting adjourned at 11:00 p.m.

A. W. Rathwell
Secretary

Amendment to the By-Laws of the Ottawa Field-Naturalists' Club

At a meeting of the Council of The Ottawa Field-Naturalists Club held on January 10, 1972. By-Law Number 4 dealing with the Duties of the Financial Committee was amended to read as follows:

"The Finance Committee shall serve in an advisory capacity to the Council on all financial matters including the investment of the Reserve Fund."

The Ottawa Field-Naturalists' Club Statement of Income and Expenses

for the year ended November 30th, 1971

Income				
Fees from Subscriptions			$ 5,077.00	
Fees from Memberships and Affiliations			6,221.50	
Sale of Back Numbers			949.69	
Sale of reprints and Magazines		$4,140.63		
Less: Cost of Materials Sold				
Inventory of Reprints (Dec. 1, 1970)	$2,081.75			
Purchases	3,142.06			
	$5,223.81			
Less: Inventory of Reprints: (Nov. 30, 70)	1,409.00	3,814.81	325.82	$12,574.01
Less Cost of Publications				
Canadian Field-Naturalist			$11,488.34*	
Trail and Landscape			1,388.75	$12,877.09
				$ (303.08)
Less Expenses				
Advertising			$ 169.00	
Bank Charges and Interest			22.10	
Depreciation on Office Equipment			105.90	
Committee Expenses: Bird Census		$ 22.00		
Bird Feeders		103.88		
Excursions & Lectures		8.59		
Delegation Expenses		50.00		
Macoun Field Club		120.26		
Natural Areas		3.25	307.98	
Honoraria			400.00	
Incidentals				
— Red Bay Camp		95.00		
— F.O.N. Convention		456.40		
— Donation to Canadian Nature Federation		150.00		
— Pollution Probe		196.00		
— Miscellaneous		30.82	968.22	
Postage			1,154.65	
Printing & Stationery			743.95	
Salaries			902.00	$ 4,773.80
Net Deficit on Operations				$(5,076.88)
Add Other Income: Donations			500.00	
Interest & Dividends			1,357.99	
Miscellaneous			195.23	
U.S. Premiums			25.76	2,078.98
Net Loss for the Year				$(2,997.90)

*This total includes the cost of five issues rather than the normal four. Vol. 84(4) (cost $2,012.00) which was paid in November of 1971 and could not be reflected in the previous years' statement.

The Ottawa Field-Naturalists' Club Balance Sheet

as at November 30th, 1971

Assets			
Current			
Cash in Bank and on Hand		$ 597.73	
Cash in Savings Account		86.68	
Bills Receivable		3,034.98	
Accrued Interest Income		1,805.48	
Prepaid Expenses		395.48	
Inventory of Reprints		1,409.00	$ 7,329.35
Fixed (at cost)			
Furniture, fixtures & equipment		$ 529.50	
Less Accumulated Depreciation		105.90	423.60
Investments & Securities			
Bell Telephone Company of Canada			
35 common shares (Market value 1,566.25)	$1,617.20		
2 preferred shares (Market value $102.00)	94.00		
Microsystems International Ltd.,			
2 shares (Market value) $10.00)	20.00	1,713.20	
Canada Savings Bonds		$10,700.00	$12,431.20
			$20,184.15
Liabilities & Equity of Surplus or Deficit			
Current Liabilities			
Income Received in Advance		$ 1,779.30	
Accounts Payable		4,152.40	$ 5,931.70
Equity of Surplus or Deficit			
Balance, December 1st, 1970		$17,623.81	
Less: Capital Cost & Write off	373.46		
Net Loss for the Year	2,997.90	3,371.36	$14,252.45
			$20,184.15

Note: Estimated Inventory of CFN in about $25,000.00

(Signed) Geoffrey Wastenys (Auditor)
A. J. Erskine (Auditor)
F. M. Brigham (Treasurer)

ERRATA NOTICES

1. Vol. 85 (4) p. 295, 2nd. paragraph of the Introduction of Miller, *Mutual Grooming by Black-tailed Deer in Northwestern Ontario*

   "Interspecific activities of large ungulates . . ." should read Intraspecific activities of large ungulates . . .

2. Vol. 85 (4) p. 312 of Bayly and O'Neil, *A Study of Introgression in Typha at Point Pelee Marsh, Ontario*

   a transposition of a two line block occurs in the left hand column, lines 8 and 9. This block, which reads:

   "mental changes, the observed variation must
   be due to genetic variation rather than plastic"

   should be placed at the top of the column.

Instructions to Contributors

Manuscripts

Authors should submit two manuscripts (original and carbon copy), each complete with abstract, tables, and illustrations. Manuscripts should be typewritten on paper measuring 8½ x 11 inches. All text matter, including quotations, footnotes, tables, literature citations and captions for figures should be double-spaced. Words meant to appear in italics should be underlined. Every sheet on the manuscript should be numbered.

Literature citations should be listed alphabetically according to author and should be placed immediately after the main body of the text in all manuscripts except in letters to the editor. In no case should any words be abbreviated; this includes references to tables and figures as well as literature citations.

The tables should be titled and numbered consecutively in arabic numerals. Tables should be placed each on a separate page after the Literature Cited. Captions to figures should be typed together on one page. Authors are requested to use at least one given name.

The **Style Manual for Biological Journals** is recommended, in general, as a guide to contributors.

Webster's New International Dictionary is the authority for spelling. However, in a case of difference in the spelling of a common name, and in the use of a variant name, a decision of a learned society is preferred.

The order in which papers are published will be as determined by the editor.

Illustrations

All illustrations should be numbered consecutively in arabic numerals. The author's name, title of the paper, and figure number should be written in the lower left corner of the sheet on which each illustration appears. The caption should **not** appear on the illustration.

Line drawings should be made with India ink on white, good quality drawing paper, blue tracing linen, or good quality blue-lined co-ordinate paper. Co-ordinate lines that are to appear on the reproduction should be ruled in black ink. Descriptive matter should be lettered, not typewritten, and all parts of the drawing should permit easy legibility even if a reduction is made.

Photographs should have a glossy finish and show sharp contrasts. For reproduction as a complete plate they should be mounted without space between prints.

For large drawings and mounted photographs the ratio of height to width should conform to that of the printed journal page (ratio of 45 up to 35 across) or roughly 7½ × 5¾ inches, but the height should be adjusted to allow for the caption if the caption is to go on the same page.

Special Charges

Authors must share in the cost of publication by paying $22.00 for each page in excess of six journal pages.

Page charges are separate from charges for illustrations and tables.

Illustrations cost $6.50 for the first five square inches plus 45 cents for each additional square inch. Tables cost up to $22.00 per page, depending upon size. The special charges for illustrations and tables are *in addition to* all charges that are levied for pages in excess of six.

Reviewing Policy of the Canadian Field-Naturalist

Articles and Notes offered for publication to the Canadian Field-Naturalist are normally sent to the Associate Editor and one other reviewer. Certain Articles receive the benefit of three or four reviews. Short Notes are reviewed by Associate Editors.

Reprints

Reprints, with or without covers may be purchased. These should be ordered at the time the galley proof is returned to the editor. Members in good standing can request a 10% reduction in reprint costs.

Schedule of charges for reprints

Number of Reprints	1 to 4 journal pages	5 to 8 journal pages	9 to 12 journal pages	13 to 16 journal pages	17 to 20 journal pages	Additional charge for Mayfair covers
100	16.00	21.00	32.00	43.00	54.00	15.00
200	20.00	27.00	40.00	53.00	66.00	22.00
300	24.00	33.00	48.00	63.00	78.00	29.00
400	28.00	39.00	56.00	73.00	90.00	36.00
500	32.00	47.00	64.00	83.00	102.00	43.00

Reprint orders of private individuals can be sent directly to the Editor, along with the corrected galley. *Institutional orders should be directed to: Box 3264 Postal Station 'C', Ottawa, Canada K1Y 4J5*

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President, Mr. A. Karvonen; *Honorary President,* Mr. R. Lister; *Vice-President,* Mrs. A. Taylor; *Treasurer,* R. Heath; *Field-Secreary,* R. W Turner; *Secreary,* Mrs. O. Young, 139 Laurier Drive, Edmonton. Alberta; *Librarian,* Mrs. R. O. Holloway, 91 Westbrook Drive, Edmonton 76, Alberta.

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Address: Box 981, Calgary 2, Alberta, *President,* W. Garry McKay; *Vice-President,* R. A. Owens; *Secretary,* Mrs. Jane Holk; *Treasurer,* Mrs. Ruth Jones; *Directors,* Dr. R. T. Ogilvie, Dr. C. D. Bird, R. Clarke, Mrs. Beryl Hallworth, D. Larson, Dr. Gordon Pritchard; *Editor,* The Calgary Field-Naturalist, John W. Price.

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The CANADIAN FIELD-NATURALIST

Published by THE OTTAWA FIELD-NATURALISTS' CLUB, Ottawa, Canada

Volume 86, No. 2 Ottawa April-June, 1972

The Ottawa Field-Naturalists' Club

FOUNDED IN 1879

Patrons

Their Excellencies the Governor General and Mrs. Roland Michener.

The objectives of the Club are to promote the appreciation, preservation and conservation of Canada's natural heritage; to encourage investigation and publish the results of research in all fields of natural history and to diffuse information on these fields as widely as possible; to co-operate with organizations engaged in preserving, maintaining or restoring quality environments for living things.

The Canadian Field-Naturalist

The Canadian Field-Naturalist is published quarterly by the Ottawa Field-Naturalists' Club with the assistance of affiliated societies and of a contribution from the Canadian National Sportsmen's Show. All material intended for publication should be addressed to the editor. Opinions and ideas expressed in this journal are private and do not necessarily reflect those of the Ottawa Field-Naturalists' Club or any other agency.

Membership and Subscription

The annual membership fee of $5.00 for individuals covers subscription to the journal. Libraries and other institutions may subscribe at the rate of $10.00 per year (volume). Applications for membership, subscriptions, changes of address and undeliverable copies should be mailed to: Treasurer, Ottawa Field-Naturalists' Club, Box 3264, Postal Station "C", Ottawa, Canada, K1Y 4J5. Return postage guaranteed. Second class mail registration number 0527.

Back Numbers

Prices of back numbers of this journal and its predecessors, (TRANSACTIONS OF THE OTTAWA FIELD-NATURALISTS' CLUB, 1879-1886, and the OTTAWA NATURALIST, 1889-1919), are obtainable from the Business Manager.

Cover photograph: North American Bison on prairie parkland in Alberta (see page 127). Photo courtesy the Department of Indian Affairs and Northern Development.

I would like to become a member of THE OTTAWA FIELD-NATURALISTS' CLUB and to receive the quarterly journal THE CANADIAN FIELD-NATURALIST

Name (Dr., Mr., Mrs., Miss) ______________________________
(In block letters)

Address ______________________________

____

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(Include postal code)

I would like my membership to start with

January of 1971 ☐

January of 1972 ☐

My membership fee of $5.00 for each year is enclosed.

____
(Signature)

(Mail to) Membership Committee,
Ottawa Field-Naturalists' Club,
Box 3264 Postal Station 'C',
Ottawa, Canada K1Y 4J5

Please note that all library and institutional subscriptions to THE CANADIAN FIELD-NATURALIST are $10.00 a year (volume)

The Canadian Field-Naturalist

VOLUME 86 APRIL-JUNE, 1972 NUMBER 2

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Articles

Notes

ERRATUM NOTICE

Vol. 86, No. 1 R. D. Weir. Spring Migration at Prince Edward Point, Ontario, page 10, right hand column —

delete 1st sentence of first paragraph beginning "We have not seen Derby Hill . . ."

The Crayfish, *Orconectes virilis,* as an Indicator of Mercury Contamination

KEES VERMEER

Canadian Wildlife Service, Edmonton, Alberta

Abstract. The crayfish, *Orconectes virilis,* is a good indicator of mercury contamination in different water bodies. Crayfish muscle contained three times as much mercury as the remaining body. Mercury levels did not differ significantly in samples collected from various parts of the shore of a highly contaminated lake.

Introduction

Surveys of mercury residues in fish and fish-eating birds have been conducted in Canada by Bligh (1970), Fimreite *et al.* (1971), Vermeer (1971) and Wobeser *et al.* (1970). As both fish and fish-eating birds migrate over large areas, they may be less reliable for pinpointing local mercury contamination than aquatic invertebrates which migrate to a lesser extent. The crayfish, *Orconectes virilis,* which lives under stones in both lakes and rivers, was investigated as an indicator of mercury contamination because this aquatic invertebrate feeds on detritus and scavenges on fish, is more restricted in its movements than fish and is the most widely distributed crayfish species in Canada (Figure 1).

Methods

O. virilis samples were collected in Manitoba from the mouth of the Saskatchewan River (53°10′N, 99°16′W) at Grand Rapids, and from Lake Winnipegosis (52°53′N, 99°47′W) at Denbeigh Point during the last half of June and the first half of July, 1971. In western Ontario they were collected from Clay Lake (50° 03′N, 93°30′W), seven miles north of Quibell, during the first half of August, 1971. Those crayfish sampling locations were selected because they represented a range from low (Lake Winnipegosis) to very high (Clay Lake) mercury levels reported in fish (Bligh, 1970). Inasmuch as Clay Lake is known to be among the most mercury-contaminated water bodies in Canada, eight sampling stations were established there (Figure 2) to determine to what extent mercury levels in crayfish varied along its shores.

The crayfish were caught in gill nets in which small pieces of bacon were inserted as bait. The baited nets were wrapped into loose bundles and weighed down with rocks in water up to approximately three feet deep along boulder-strewn river and lake shores. Initially the entangled crayfish were collected from nets placed out overnight, but later the nets were inspected every 4 to 6 hours because crayfish were also observed to be active during the day.

The crayfish were stored in glass jars and preserved by freezing. One hundred whole crayfish, 10 from the Saskatchewan River, 10 from Lake Winnipegosis and 80 from Clay Lake were analyzed individually for mercury residues. The abdominal muscles as well as the remaining bodies of another 10 crayfish from the Saskatchewan River were also individually analyzed. The crayfish were analyzed by the

FIGURE 1. Distribution of *Orconectes virilis* in Canada, shown in shaded area (Aiken, 1967; Crocker and Barr, 1968).

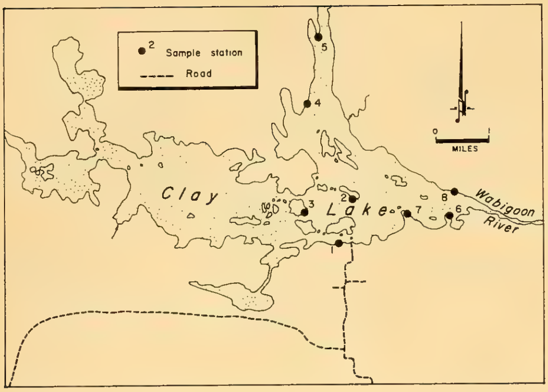

FIGURE 2. Sample stations for crayfish at Clay Lake, Western Ontario.

flameless absorption spectrophotometry technique by Dr. L. M. Reynolds from the Ontario Research Foundation in Ontario as described in Vermeer (1971). Mercury residues are given in parts per million (ppm) wet weight.

Results and Discussion

Table 1 shows a highly significant variation in mercury levels between crayfish from Clay Lake, the Saskatchewan River and Lake Winnipegosis. A similar variation in mercury residues has also been found in fish from these three water bodies. Bligh (1970) reported that pike, *Esox lucius,* and walleye *Stizostedion vitreum,* had average mercury levels in ppm of 8.03 and 7.71 respectively at Clay Lake; 0.40 and 0.33 at Lake Winnipeg at Grand Rapids and 0.13 and 0.16 at Lake Winnipegosis.

It can be seen from Table 1 that the average mercury levels did not vary significantly between crayfish from the eight different stations at Clay Lake. The non-significant variation in mercury levels between crayfish at that lake is partly the result of a variation in their body weights (Figure 3).

Mercury residue levels were also determined for the abdominal muscles and the remaining bodies of 10 crayfish taken from the mouth of the Saskatchewan River at Grand Rapids. The mean and 95 per cent confidence interval of their body weights was 6.317 ± 0.692 gram. The means and 95 per cent confidence intervals of the mercury levels in the muscles and remaining bodies were 0.078 ± 0.017 and 0.027 ± 0.007 ppm respectively. Hence, muscle appears to contain about three times as much mercury as the remaining body of crayfish.

From the above observations it can be concluded that *O. virilis* is a good indicator of mercury levels in different water bodies provided the crayfish are within the same range of body weights. At low levels of contamination crayfish muscle appears to be a more reliable indicator of mercury than the whole animal. A

TABLE 1. — Means and 95% confidence intervals of mercury residues and body weights of the crayfish, *Orconectes virilis*

Locality	No. of Crayfish	Mercury residues in ppm	Body weight in grams
Clay Lake, Western Ontario			
Sample station 1	10	1.071 ± 0.436	12.949 ± 2.535
Sample station 2	10	0.891 ± 0.174	10.453 ± 2.646
Sample station 3	10	1.103 ± 0.244	10.274 ± 2.681
Sample station 4	10	1.012 ± 0.230	7.835 ± 3.620
Sample station 5	10	0.777 ± 0.153	8.059 ± 3.224
Sample station 6	10	1.051 ± 0.265	8.919 ± 2.848
Sample station 7	10	0.910 ± 0.171	6.952 ± 2.792
Sample station 8	10	0.753 ± 0.112	6.052 ± 1.876
Clay Lake, all stations	80	0.946 ± 0.076	8.937 ± 0.943
Saskatchewan River Grand Rapids Manitoba	10	0.067 ± 0.012	8.161 ± 0.897
Lake Winnipegosis, Denbeigh Point, Manitoba	10	0.012 ± 0.000	6.976 ± 0.829

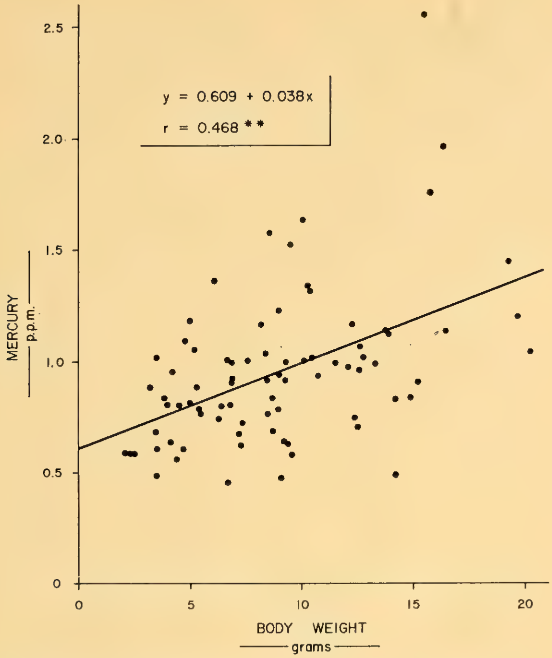

FIGURE 3. Relation between mercury residues in crayfish and their body weights (**$p<0.01$).

sample of 10 crayfish from a given shoreline location at Clay Lake is generally representative of contamination of crayfish at other parts of the shore of that lake.

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My thanks go to Dr. D. W. Barr, of the Royal Ontario Museum for assistance with species identification, to Mr. D. Patterson of Grand Rapids, for teaching me the method of catching crayfish and to Mr. B. Campbell of Quibell, for aiding me with the collection of crayfish at Clay Lake.

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Parasites and Diseases of Bison in Canada. III. Anthrax Outbreaks in the Last Decade in Northern Canada and Control Measures

L. P. E. Choquette, E. Broughton, A. A. Currier, J. G. Cousineau[1] and N. S. Novakowski

Canadian Wildlife Service, Environment Canada, Ottawa K1A 0W1, Canada

Abstract. The natural history of anthrax is reviewed. Outbreaks of the disease in northern Canada, where more than 1000 bison died from 1962-1971, are discussed. Control measures are described, including vaccination, surveillance of the bison herds, and disposal of carcasses.

Introduction

Anthrax is an infectious disease caused by the bacterium *Bacillus anthracis*. It is nearly universal in its geographical distribution and has been reported from a wide variety of mammals, many of them herbivores. Man is also susceptible. The occurrence of anthrax in wild animals was reviewed recently (Choquette 1970). In Canadian wildlife, it was first diagnosed in 1962 during an outbreak in bison *(Bison bison bison)* in the Northwest Territories (Novakowski et al. 1963) where there have been further outbreaks in the last decade.

The causative agent of anthrax multiplies under aerobic conditions and forms spores when exposed to the atmosphere under suitable conditions of humidity and temperature. When it gains access to the animal body, it multiplies rapidly producing a septicaemia.

The vegetative or active stage of the bacterium occurs in the blood, organs, tissues and in swellings. In its vegetative stage *B. anthracis* is not very resistant to dessication, high temperature or chemical disinfectants. If ingested, the bacilli are destroyed by the gastric juice. In an intact carcass the bacilli are destroyed within a few days by putrefaction, except at temperatures of 41°-50°F, when they survive a few weeks (Minett 1950, Stein 1947a, 1947b). However, the carcasses of wild animals usually do not remain intact long enough to allow for the destruction of the bacilli by putrefaction.

When material containing bacilli (e.g. discharges of a diseased animal) is exposed to air, spores are formed. Bacilli within the carcass will not sporulate unless the carcass is opened. The spores are not destroyed by gastric juice and are very resistant to severe environmental temperatures, sunlight, prolonged drying, and many of the standard disinfectants. They may retain their viability for many years in the soil (Wilson, and Russell 1964) as well as in water, hide, hair, and other animal matter.

In herbivores, anthrax is essentially a soil-borne infection and animals usually contract the disease by ingesting grass or water contaminated with spores of *B. anthracis*. Soil and water contamination is often caused by carcasses of animals that have died of the disease or have been dismembered by carrion eaters, as well as by the excreta and discharges of diseased animals. Contamination may also originate from the excreta of animals that have fed on infected carcasses or from the soiled bodies of living animals (Choquette 1970). Animals that wallow on contaminated soil can carry infected mud or soil from one place to another. It has also been shown that a number of bloodsucking flies, including tabanids, can transmit the disease through direct inoculation; non-biting Diptera such as blowflies and flesh flies feeding and developing in decaying animal matter can also play a role in the dissemination of the disease (Choquette 1970).

The occurrence of anthrax is largely influenced by conditions which determine soil moisture, surface temperature, plant growth,

[1]Present address: Département de Microbiologie, Faculté de Médecine, Université Laval, Québec.

surface water and evaporation, i.e., the suitability of the environment for the survival of the spores. These conditions vary considerably throughout the world (Choquette 1970).

The recurrence of the disease is due to the resistance and viability of the spores in suitable environmental conditions. As shown by several authors (Choquette 1970), the persistence of the infection in the soil is related to the activity of soil bacteria as well as to the type of soil and soil pH. While under certain conditions soil contamination may persist for many years, it may under other conditions disappear in a relatively short time.

The clinical picture and post mortem appearance of anthrax in bison are essentially the same as in livestock. Sudden onset and rapidly fatal course, exudation of tarry blood from the anus and the nostrils, enlargement of the spleen and oedematous swellings in various parts of the body are common features. A positive diagnosis of anthrax can be made only by microscopic and bacteriological examination of material from cadavers.

Outbreaks in the Northwest Territories and Wood Buffalo National Park

The bulk of the bison population in Canada is found in Wood Buffalo National Park, a 17,000 square-mile area straddling the Alberta-Northwest Territories border. At present there are between 12,000 and 14,000 bison in the park and in areas adjacent to the park limits and north of the 60th parallel.

Anthrax occurred in bison in the Northwest Territories in 1962, in a 700 square-mile area (Zone 1, Fig. 1) (60° 35′ to 60° 00′ N by 112° 15′ to 113° 15′ W) in the vicinity of Hook Lake, between the Slave River in the west and the Taltson River in the east (Novakowski et al. 1963). Hook Lake is located 60 miles north of Fort Smith, Northwest Territories, and about 15 miles from the northeast boundary of Wood Buffalo National Park. At that time, there were approximately 1,300 bison in the area. Altogether 281 carcasses of bison were found between the end of July and the end of August that year.

During the summer of 1963, between the end of June and the middle of July, 12 bison died of anthrax in the Hook Lake area (Cousineau and McClenaghan 1965). However, that summer the disease also occurred on the west side of the Slave River in an area adjacent to the northeast boundary of Wood Buffalo National Park. There were approximately 2,500 bison in the area at the time of the outbreak. Most of the 269 bison carcasses found between the second week of July and the middle of August were in the vicinity of Grand Détour, an area named after a bend in the Salve River (Zone 2, Fig. 1).

In July and August 1964 anthrax occurred again in the Hook Lake and the Grand Détour areas where respectively 44 and 202 bison carcasses were found. During that period the disease also occurred in bison in Wood Buffalo National Park: 46 carcasses were found in the vicinity of the Hay Camp Station (Zone 3, Fig. 1) and seven in the Lake One area (Zone 4, Fig. 1), south of the Peace River.

During the summer months of 1965 and 1966 there were no bison deaths attributable to anthrax, although nine bison carcasses and the remains of 13 others were found in Wood Buffalo National Park south of the Peace River. None of the intact carcasses examined exhibited lesions suggestive of anthrax and laboratory studies of tissues from these animals were negative for *B. anthracis*. This does not prove that some of these animals did not die of anthrax. However, it does suggest that there were few if any bison deaths from anthrax in both 1965 and 1966.

During the summer of 1967, anthrax broke out in bison in the Lake One, French Lake and Lake Claire areas of Wood Buffalo National Park (Zone 4, Fig. 1). Between August 3 and September 7, 118 bison carcasses or remains were found and burned. In addition, two bison exhibiting symptoms of anthrax were shot. The outbreak was confined to the above-mentioned areas.

In 1968, only one death positively attributable to anthrax was recorded. The carcass of a non-vaccinated animal was found in the general area where the disease had occurred

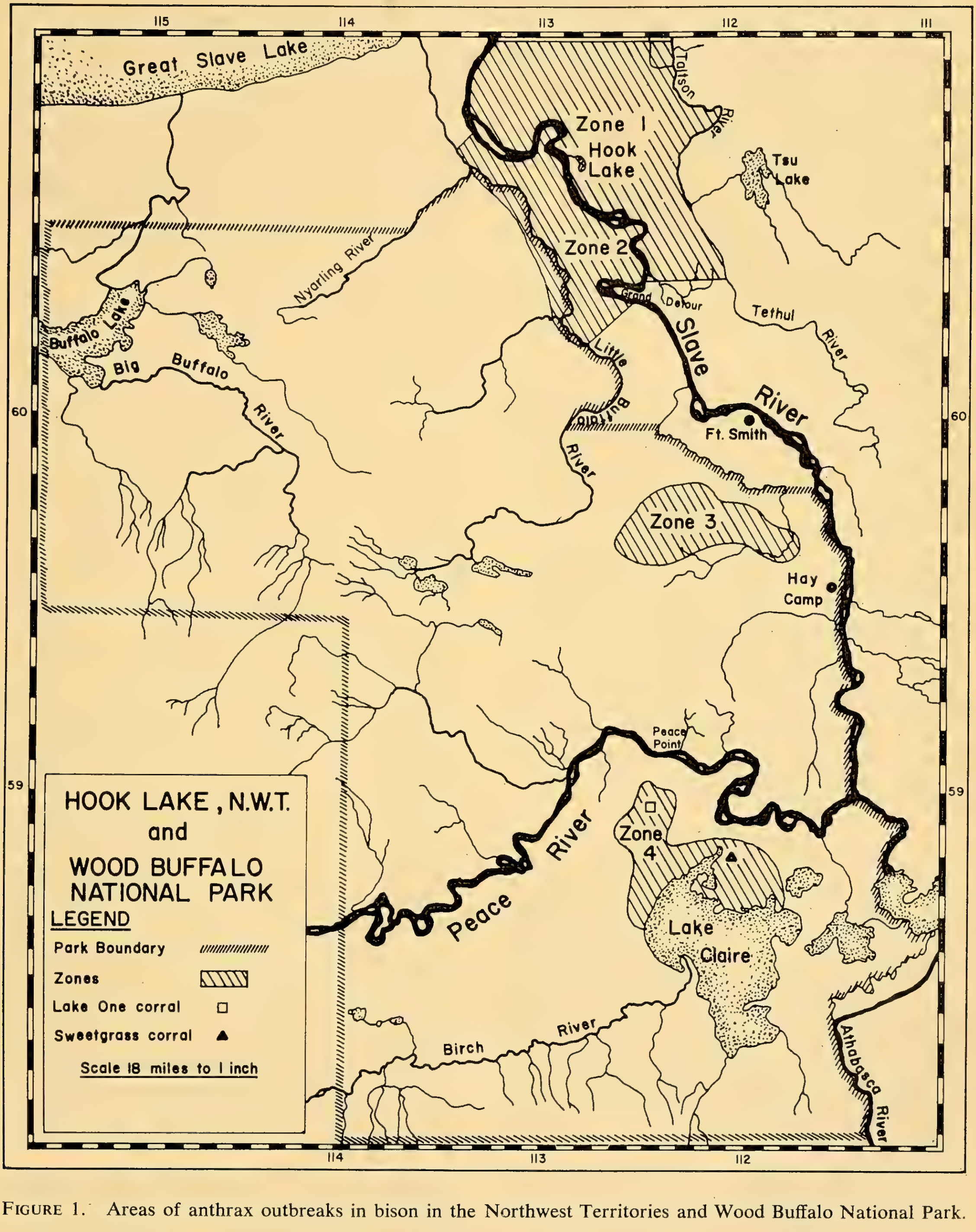

FIGURE 1. Areas of anthrax outbreaks in bison in the Northwest Territories and Wood Buffalo National Park.

in 1967. In 1969 and 1970 there were no bison deaths attributable to anthrax.

In 1971, from mid June to mid July, 31 bison deaths attributable to anthrax were recorded in the Hook Lake area (Zone 1, Fig. 1). There were approximately 1,500 bison in the whole Hook Lake area but no more than 130 animals in the immediate area where the deaths occurred.

In all the outbreaks reported here the field diagnosis of the disease was confirmed by laboratory examinations at the Animal Pathology Laboratories of the Health of Animals Branch, Canada Department of Agriculture.

Control Measures

Control measures consisted mainly of the continued surveillance of the bison herds for evidence of anthrax, the prompt disposal of bison carcasses (or their remains) when the disease was involved, and vaccination.

In the past decade bison herds in areas where anthrax occurred in the Northwest Territories and in adjacent Wood Buffalo National Park have been kept under continual surveillance during the summer months when the disease was likely to break out. Helicopters or fixed-wing aircraft with a slow cruising speed were used for this purpose. At the time of outbreaks, air surveillance is also supplemented by crews walking through bushy areas to search for cadavers.

During the outbreaks in 1962, 1963 and 1964 the cadavers were disposed mostly by burying the limed carcasses under mounds of earth, with the aid of earth-moving equipment. In a few instances carcasses were burned. Beginning with the outbreak in 1967, whenever possible, carcasses and remains have been incinerated using fuel oil and wood, in a pit filled in after the carcass has been completely burned. Also whenever possible the area immediately around the filled-in pit is burned off and quicklime spread over it to discourage bison from wallowing over the disposal site. The advantage of incineration over burial is that it eliminates the danger of contamination of the area surrounding the burial mound by seepage, as well as removing the possibility of scavengers gaining access to possibly infected material. In places where it is not possible to dig a pit because of the high water table, cadavers or their remains are incinerated on the surface and the disposal site covered with lime.

Carcasses or remains found during the summer months were examined in an attempt to determine the cause of death and if warranted material collected for laboratory examination. Except when the cause of death was obvious (e.g. accidents, drowning, predation) the carcasses or their remains were disposed by incineration, if at all possible.

At the time of outbreaks in 1962, 1963, 1964 and 1967 attempts were made to move herds of unaffected animals from the contaminated areas and to prevent their use of such areas. However, these attempts were not too successful as usually within a few weeks bison herds had returned to the areas from which they had been driven earlier. Also, attempts to move non-herd males from contaminated areas were unsuccessful in most cases. During the outbreak at Hook Lake in 1971, 41 bison in the contaminated area were shot rather than risk their becoming infected and spreading the disease.

Mass vaccination with an avirulent anthrax spore vaccine (living) was initiated in 1965. That year and in 1966 respectively 700 and 577 bison were vaccinated at Hook Lake in the Northwest Territories and 3,591 and 3,587 in Wood Buffalo National Park, most of them at Sweetgrass Station (at Lake Claire) and at Lake One (Zone 4, Fig. 1). No animals were vaccinated in 1967. Vaccination was resumed in 1968 at Sweetgrass Station. That year and in 1969, 1970 and 1971 respectively 940, 3,021, 3,452 and 779 bison were vaccinated.

Discussion

The diagnosis of anthrax in bison in the Northwest Territories in 1962 was the first instance of the disease being recognized in any wildlife species in Canada (Novakowski et al. 1963).

Altogether 1,003 bison, 829 in the Hook Lake and Grand Détour areas in the Northwest Territories and 174 in Wood Buffalo National

Park, died during the course of outbreaks between 1962 and 1971 inclusively. Certainly 1,003 is a minimum figure. It is likely that a number of infected carcasses were not found because of their location or their rapid dismemberment by scavengers.

In these outbreaks the death rate was higher in males than females, with young animals rarely affected. This has also been observed in outbreaks of anthrax involving kudus *(Strepsiceros strepsiceros* (Pallas)) in Kruger National Park in South Africa. Behavioral differences may account for this (Pienaar 1961, Novakowski et al. 1963).

Irrespective of when and how anthrax was introduced into northern Canada, local ecological conditions favoured the persistence of soil contamination and the subsequent occurrence of explosive outbreaks, at least in some areas at more or less long intervals.

Contaminated grass (or water) was probably the main source of infection. On several occasions bison were seen sniffing carcasses and even licking blood running out of the anus and the nostrils. Biting flies may have also played a role in the transmission of the disease when it reached epizootic proportions as in the Hook Lake and the Grand Détour areas in 1962 and 1963 respectively (Cousineau and McClenaghan 1965).

At times of outbreaks affected herd bison may contribute to the spread of the infection over large areas as the herds move. Affected adult male animals temporarily or permanently not part of a herd usually roam in a more or less limited area and as a result these areas become more heavily contaminated.

It is likely that in 1963 avian carrion eaters played a role in the spread of anthrax from the area of Hook Lake across the Slave River to the Grand Détour area some 40 miles away and from these localities into relatively distant areas of Wood Buffalo National Park in 1964. Anthrax spores have been found in the cloaca of gulls *(Larus argentatus)* which had fed on bison carcasses (Choquette 1970). A number of authors have pointed out the role of avian carrion eaters in the spread of anthrax (Choquette 1970).

It is also likely that mammalian scavengers such as coyotes, foxes and bears that fed on bison carcasses also contributed to the spread of the disease in the localities where it occurred.

Mass vaccination of wildlife is limited almost exclusively to herd animals which can be corralled such as bison. In 1965, 1966 and 1970 the bulk of the bison population in some of the areas where anthrax had previously occurred had been vaccinated.

It was realized that mass vaccination would not eliminate any possibility of anthrax occurring in bison in contaminated areas. However, it was felt that the vaccination of a high percentage of the bison population in these areas would prevent explosive outbreaks by correspondingly reducing the availability and dissemination of inoculum.

Since there were no bison deaths attributable to anthrax in 1965, 1966, 1969, 1970, and only one in 1968, in the Northwest Territories and Wood Buffalo National Park, and none in the latter locality in 1971, it is not possible to evaluate the efficacy of the vaccine in bison under field conditions, nor the effect of mass vaccination or of non-vaccination on the prevalence or occurrence of the disease. Because of a lack of data which could be evaluated statistically, Sterne (1959) questioned the efficacy of anthrax vaccination in the control of the disease in livestock. Obviously the same applies to bison or other wildlife species.

It is also recognized that whenever any large-scale immunization is undertaken without strictly non-immunized controls, it becomes impossible to show in the statistically accepted form that a gradual decrease in the prevalence of the disease is due to previous immunization (Sterne 1959). Nevertheless, it is felt that a high vaccination rate in contaminated areas would lessen the possibility of explosive outbreaks. Annual mass vaccination is only one control measure. In areas where anthrax has occurred, continued surveillance is maintained for any sign of the disease, so that immediate steps can be taken for the proper disposal of carcasses to eliminate sources of infection and to prevent the spread of the disease in order to minimize animal losses.

Summary

The natural history of anthrax, an infectious disease, is reviewed briefly. Outbreaks in bison in the Northwest Territories and Wood Buffalo National Park between 1962 and 1971 claimed at least 1,003 animals.

It is not known when and how anthrax was introduced into northern Canada where local ecological conditions favoured the persistence of soil contamination and the subsequent occurrence of explosive outbreaks. In addition to affected bison, it is likely that carrion eaters and scavengers also contributed to the spread of the disease.

Control measures consisted mostly of the continual surveillance of the bison herds during the summer months for evidence of the disease, particularly in areas where it had occurred previously, the disposal of bison carcasses and mass vaccination. In the absence of bison deaths attributable to anthrax in certain years when animals were vaccinated it is not possible to evaluate the efficacy of the vaccine in bison under field conditions, or the effect of mass vaccination on the prevalence or occurrence of the disease. Though it is probable that vaccination alone would not eliminate any possibility of the disease occurring, it is likely that a high vaccination rate would prevent large explosive outbreaks of anthrax in bison in contaminated areas.

Acknowledgement

The valuable collaboration of Mr. K. F. Cooper, Wood Buffalo National Park, Fort Smith, N.W.T., is gratefully acknowledged. The authors extend their thanks to their many colleagues in the Department of Agriculture for their collaboration in the implementation of control measures.

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Fishes of the Northeastern Wood Buffalo National Park Region, Alberta and Northwest Territories

Joseph S. Nelson[1] and Martin J. Paetz[2]

[1]Department of Zoology, The University of Alberta, Edmonton, Alberta
[2]Fish and Wildlife Division, Department of Lands and Forests, Edmonton, Alberta

Abstract. Five species of small fishes (northern redbelly dace, fathead minnow, pearl dace, brook stickleback, and Iowa darter) have their known northern distributional limits in landlocked lakes and small creeks in the northern Wood Buffalo National Park region. They are surprisingly abundant along their northern fringe but are poorly known to the immediate south. The majority of individuals of two species of stickleback (brook and ninespine sticklebacks) fail to develop the pelvic skeleton in several localities. Habitats within the region are unusual, consisting of karst topography (with sinkhole lakes and the possibility of underground drainage connections) and streams of relatively high salinity.

Introduction

The sinkhole area south and west of Fort Smith, Northwest Territories, has a relatively rich fish fauna, quite unlike that of the adjacent Slave River and aquatic habitats to the immediate north and south. Furthermore, several species have their northern and southern distributional limits in the vicinity of Fort Smith. The area under study, straddling the Alberta-Northwest Territories border, exhibits classical karst topography with recent and pre-Pleistocene sinkholes and salt springs. The probable occurrence of underground water channels connecting various sinkholes raises the possibility of a means of fish dispersal not present in most other areas. The purpose of the present paper is to describe the fishes collected by the authors in 1970 and 1971 in areas accessible by road.

Materials and Methods

Between June 24-29, 1970 and July 5-9, 1971, we collected fish in parts of the northeastern Wood Buffalo National Park region (Figure 1, Table 1). A nylon minnow seine with bag and 3/16-inch mesh was used whenever possible. Rotenone was employed where seining was not efficient and where the effects of this chemical could be confined. Extreme caution was employed in its use in order to avoid permanently altering any population. Specimens were fixed in formalin, with the colour preservative Ionol, and later transferred to isopropyl alcohol. They are deposited in The University of Alberta Museum of Zoology (UAMZ 2140 to 2204 for 1970 and UAMZ 2540 to 2578 for 1971).

Samples of water were taken from four sites and analyzed by the Water Pollution Control Board, Alberta Department of the Environment. After our survey we were pleased to learn that Dr. R. Green of the Research Council of Alberta had made a detailed study of water chemistry in much of Wood Buffalo National Park in 1970. Some of his extensive data are given here.

Geography and Water Chemistry

Many scientific investigations have been made in Wood Buffalo National Park. Among others, Raup (1933), Soper (1939, 1941), and Fuller (1962), give general descriptions of the physical and biological features. Within the area we collected lies a long limestone escarpment about 15-25 miles (24-40 km) west of the Slave River. To the west of the escarpment lies the Alberta Plateau while to its east lies the Salt Plains. These plains consist of a prairie strip about 15 miles (24 km) wide and extend to the Slave River lowlands.

The study area (Figure 1) lies within drainage which flows into Great Slave Lake and eventually reaches the Arctic Ocean via the Mackenzie River. The dominant river is the extremely large and silty Slave which carries an average of 131,000 cubic feet per second

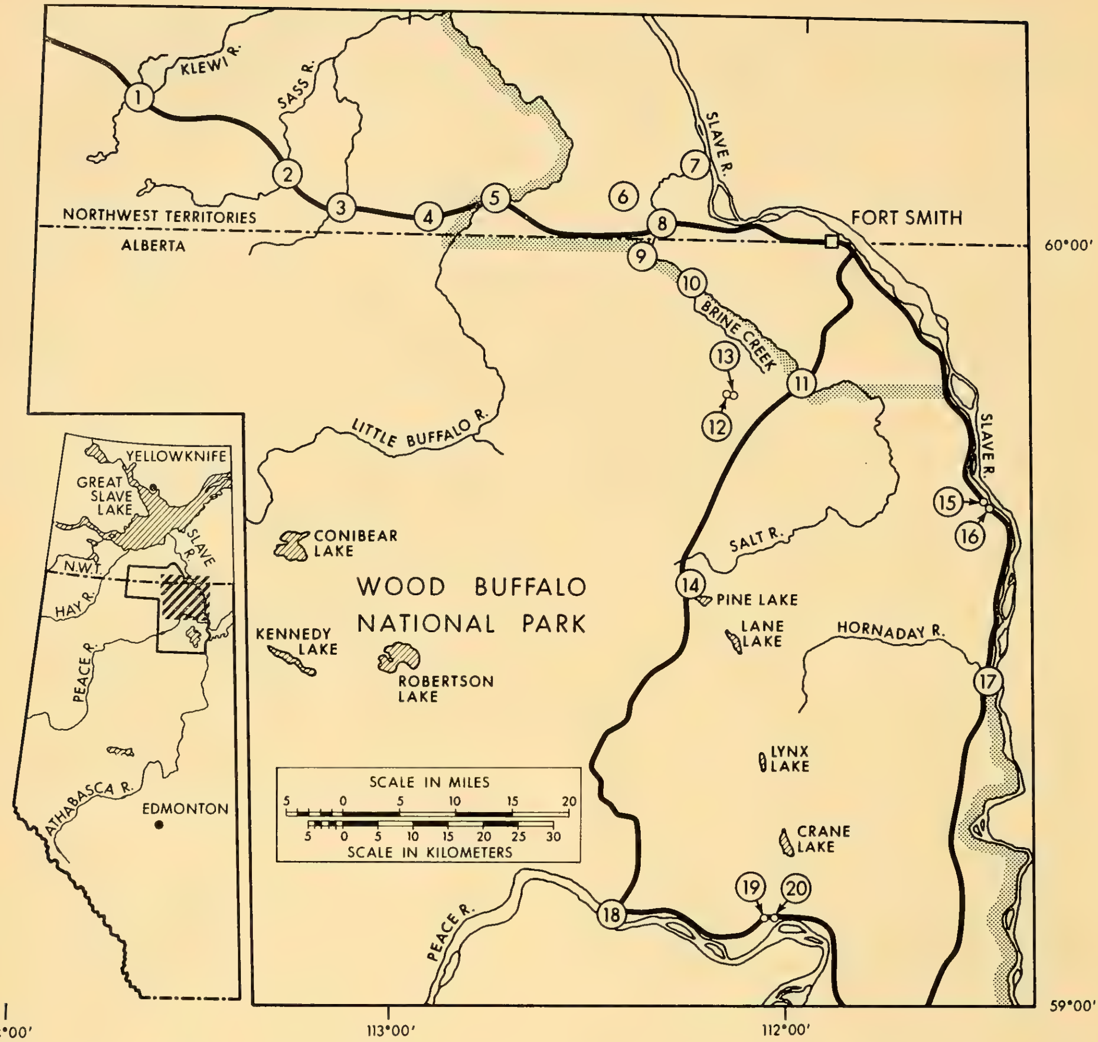

FIGURE 1. Localities from which fish were collected. The heavy black line represents the main roads. In the inset map the extent of Wood Buffalo National Park is shown by a solid black line. The boundary is indicated by stippling on the larger map.

across the Alberta-Northwest Territories border (Paetz and Nelson, 1970). This represents about 87% of the water that flows out of Alberta (drainage from most of Alberta and portions of British Columbia and Saskatchewan). The Slave River is characterized by four rapids, the downstream one at Fort Smith being Rapids of the Drowned (=Fort Smith rapids) and the upper-most (Cassette) being almost 14 miles (22 km) to the south, just north of Fitzgerald, with the Mountain Portage and Pelican rapids in between. Each of the rapids consists of several channels cut in Precambrian rock, which is exposed on the adjacent islands (e.g., Figure 2). Although the rapids may be ecological barriers none of them would form a physical barrier to upstream migration for the fish inhabiting the river downstream.

In the plateau to the west of the Slave River lie numerous sinkholes and sinkhole lakes. The

dominant bedrock is gypsum and limestone-dolomite (in contrast to the Precambrian Shield to the east of the Slave and a few Precambrian outcrops on the west bank). Details of the karst formation and the chemical composition of the waters (Table 2) have been studied by Drs. L. A. Bayrock and R. Green, respectively, of the Research Council of Alberta. Some of the sinkholes may have underground connections (in the past, at least, if not presently — perhaps they have become clogged with washed-in sediment or by collapsed roof materials). This would seem especially likely for the sinkholes between Pine and Lynx lakes where the presence of an extensive valley sink is suggested. The Rainbow lakes may also be so connected. The sinkholes (formed by solution and by collapse of overburden roof strata into dissolved underground caverns) range from relatively recent collapse sinks such as at the Nyarling Warden Station (Figure 3) to ones such as Rainbow (Figure 4) and Pine lakes with well eroded shorelines. Pine Lake has a maximum depth of 78 feet (24 m) and the Rainbow lakes also appear relatively deep. Small sinkhole lakes and ponds are also numerous. Fox Holes Lake (Figure 5), consisting of several ponds outside of Wood Buffalo National Park, was the only pond we investigated and found fish. Its depth seldom exceeds 1 foot (30 cm — although the bottom is quite soft) and it is relatively high in total dissolved solids (Table 3). Perhaps in winter the salts become concentrated, thereby leaving more unfrozen "bottom" than would otherwise be the case. In the flat "salty" ground around Fox Holes we observed one common garter snake *(Thamnophis sirtalis),* which is about as far north as snakes occur in North America (they are reported to be common along the Little Buffalo River). Small lakes and ponds are numerous in the lower Sass (in the whooping crane nest-

FIGURE 2. Portage Mountain Rapids on the Slave River, the first upstream rapids within the Alberta border. Precambrian strata forms the east (far) bank of the river and is exposed on the islands.

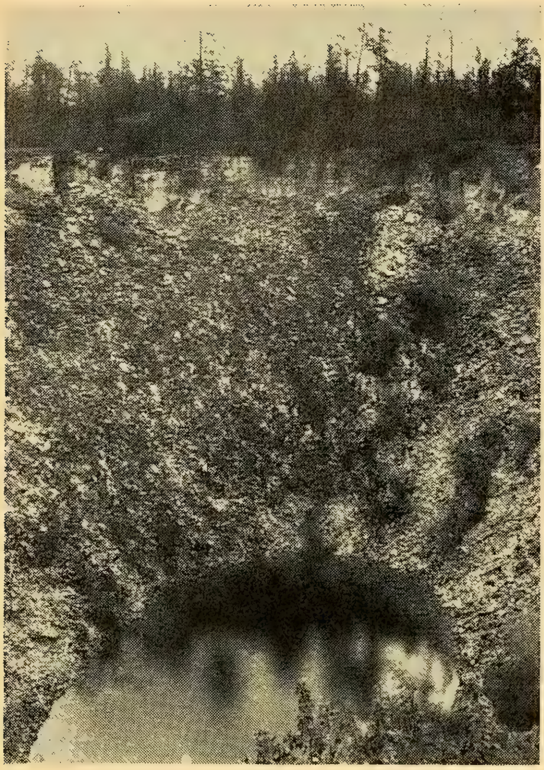

FIGURE 3. A collapsed sinkhole at the Nyarling Warden Station (Angus Tower) located northwest of the Nyarling River off the northwest corner of Figure 1. No fish were found in the water (see Table 3 for water analysis).

ing area) and fish are noted from these by Allen (1956).

Two main rivers cut across the study area within the plateau. Salt River originates near Pine Lake at McNeil Lake and empties into the Slave. It is exceptionally high in total dissolved solids (except in the extreme headwaters), with the major ions being sodium and chloride (Tables 2 and 3). Some of its tributaries are springs which according to the data of Dr. R. Green may range as high as 314,070 ppm in total dissolved solids (with Na^+ at 118,438 ppm and Cl^- at 189,000), about 9 times that of sea water. The Little Buffalo River (Figure 6) drains directly into Great Slave Lake, southwest of Fort Resolution. Its tributaries include the Klewi and Sass (and its tributary, the Preble). Unlike the Salt, these streams are not exceptionally high in total dissolved solids and the major ions are calcium and sulphates, typical of many streams elsewhere. Campbell Falls on the Little Buffalo (Figure 7), north of the highway along the escarpment, presents an obvious barrier to upstream movement. Several streams in the northern Wood Buffalo National Park region are subterranean for part of their course. For example, the Nyarling for about 9 miles (14 km) flows underground in a valley sink, with a large dry river bed on the surface for most of this distance.

FIGURE 4. A sinkhole lake with a well-developed shoreline, Rainbow Lake number 1.

FIGURE 5. A portion of Fox Holes Lake, a shallow soft-bottomed series of ponds where ninespine sticklebacks are common.

Amongst the sites from which we collected fish the lowest elevation is about 570 feet (172 m) at the mouth of the Salt River, while the highest is about 880 feet (268 m) at Pine Lake. The highest elevation within the study area is only a little over 1,000 feet (305 m), southwest of Pine Lake.

The Fishes

Former Canadian Wildlife Service biologists working in Wood Buffalo National Park, Drs. W. A. Fuller and N. S. Novakowski, and presently Mr. E. Kuyt, have made fish collections. Allen (1956) during his extensive studies on the whooping crane made collections of aquatic organisms from the shallow lakes inhabited by the cranes. The fishes he collected were identified by Drs. R. R. Miller and R. M. Bailey of the University of Michigan. The four known indigenous species to Pine Lake were collected by Mr. E. Kuyt in 1966 and identified by Dr. D. E. McAllister of the National Museum of Natural Sciences, Ottawa. Earlier collections were made by Drs. Fuller and Novakowski beginning in 1949 and 1957, respectively, but these have not been seen by us. Mr. C. G. Paterson, while employed by the Alberta Fish and Wildlife Division, made limited collections in 1966 in the Salt River area. Some of his results are reported in Paetz and Nelson (1970). Unfortunately, in some of the earlier collections the locality cannot be definitely determined.

Altogether, we collected 20 species of fish, one of which is an introduction. Another seven species and a hybrid are definitely known from the region, two of the species and the hybrid are introductions, making 25 native species known from the study region. The fishes are as follows:

Salmonidae

RAINBOW TROUT — *Salmo gairdneri.* Map number — 14.

Rainbow trout were first introduced into Pine Lake in 1958. In 1959 Pine Lake was restocked and fry were also planted in the five Rainbow lakes (southwest of Fort Smith), Seven Mile Lake (60°00′; 112° 38′), Little Buffalo River above Campbell Falls, and Salt River (report of N. S. Novakowski). There is no evidence of reproduction at any of these sites. Fry were common inshore in Pine Lake in 1971 from a planting made earlier that year.

Several other salmonids have been introduced but were not collected by us (see details under Other Species).

Esocidae

NORTHERN PIKE — *Esox lucius.* Map numbers — 9,10,11,15,16,17, and 20.

The circumpolar northern pike are common in Salt River. At the mouth of Brine Creek in 1970 adults were disproportionately more numerous than the

young. They were not observed at the same site in 1971. Pike are also present in the lower reaches of tributaries to the Slave and Peace rivers but absent from the landlocked lakes examined by us. They are particularly abundant at the mouth of the Hornaday and may be present in the landlocked Lane Lake which may at one time have been connected with the Hornaday.

Cyprinidae

NORTHERN REDBELLY DACE — *Chrosomus eos.* Map numbers — 2,3,5, and 13.

Northern redbelly dace are common in Sass River and Rainbow Lake number one. Males in Rainbow Lake were in breeding colouration, possessing a bright reddish-orange band on the lower side (above which were black, pale yellow, and straw-brown bands). The most northerly known record for this species is in Wood Buffalo National Park (McPhail and Lindsey, 1970).

FINESCALE DACE — *Chrosomus neogaeus.* Map numbers — 2,3, and 5.

Finescale dace are common in Little Buffalo and Sass rivers. Allen (1956) notes them from ponds in the lower Sass.

LAKE CHUB — *Couesius plumbeus.* Map numbers — 2,3, and 5.

Lake chub are common only in Little Buffalo River and Preble Creek. It is, however, the most widespread minnow in the Northwest Territories (McPhail and Lindsey, 1970).

FLATHEAD CHUB — *Platygobio gracilis.* Map number — 18.

This large minnow was taken in the Peace River at Peace Point and farther downstream at Carlson Landing (not on Figure 1). It is reported to occur in the Slave River.

EMERALD SHINER — *Notropis atherinoides.* Map numbers — 15 and 18.

Emerald shiners were abundant at site number 15, where 65 specimens were obtained.

SPOTTAIL SHINER — *Notropis hudsonius.* Map numbers — 2 and 15.

Spottail shiners, like emerald shiners, are very spotty in their distribution within the study area. They were never abundant.

FATHEAD MINNOW — *Pimephales promelas.* Map numbers — 2,3,5,13, and 14.

FIGURE 6. Little Buffalo River immediately north of the highway west of Fort Smith. Low water conditions prevailed.

Fathead minnow are at their northern distributional limits in Wood Buffalo National Park. Despite this fact they are common or abundant at all sites except Little Buffalo River. Allen (1956) collected them from ponds in the lower Sass. Interestingly, they are not known to occur for about 300 miles (483 km) farther south in Alberta.

LONGNOSE DACE — *Rhinichthys cataractae*. Map numbers — 17 and 18.

Within the area of study, longnose dace are common only in the Peace River. We have taken them in the Buffalo River (60°42′; 114°55′), 116 miles (186 km) northwest of Fort Smith.

PEARL DACE — *Semotilus margarita*. Map numbers 1,2,3, and 5.

Pearl dace are common at the same sites as finescale dace and lake chub. Only one specimen was collected in Klewi River. Allen (1956) notes the species in ponds in the lower Sass and the most northerly occurrence for this species is reported to be the lower Sass River (McPhail and Lindsey, 1970).

Catostomidae

LONGNOSE SUCKER — *Catostomus catostomus*. Map numbers — 2,3,7,8,11,16,17, and 18.

Longnose suckers are common in many of the above areas, particularly so at the mouth of the Hornaday. Like the northern pike, it is very widespread in northern North America.

WHITE SUCKER — *Catostomus commersoni*. Map numbers — 3,5,10, and 17.

White suckers were common only in Preble Creek and Little Buffalo River (where the longnose sucker was rare or not taken). Elsewhere, only a few individuals were taken and these were usually adults.

Gadidae

BURBOT — *Lota lota*. Map numbers — 15, 16, and 17.

The circumpolar burbot are present in the lower reaches of several Slave River tributaries. They are present in Little Buffalo River but apparently absent

FIGURE 7. Campbell Falls on the Little Buffalo River at the escarpment north of the highway west of Fort Smith, cut into Devonian gypsum and carbonate rocks.

from the Salt River (except possibly near the mouth). It was the most abundant species in limited collections on the Slave River.

Gasterosteidae

BROOK STICKLEBACK — *Culaea inconstans*. Map numbers — 1,2,3,4,5,8,9,10,12,13,14,19, and 20.

Despite being at the northern end of their known range in Wood Buffalo National Park, brook sticklebacks are very abundant in many localities. Allen (1956) reported them from ponds in the lower Sass. In the Pine and Rainbow lakes area most or all specimens lack the pelvic skeleton (Table 4). Streams to the north and south contain individuals which normally always possess the pelvics.

NINESPINE STICKLEBACK — *Pungitius pungitius*. Map numbers — 6,7,8,9,10,11, and 14.

The more northerly and widespread ninespine stickleback is relatively more restricted than the brook stickleback but was more numerous than the latter species in areas of overlap. Also, like the brook stickleback, many specimens lack all or part of the pelvic skeleton (Table 4). Most specimens from three of the Fox Holes lakes completely lacked the pelvics. In the Salt River a high proportion did not have a complete pelvic skeleton while most of the brook sticklebacks had it fully developed. The reverse situation is true for Pine Lake.

The tapeworm, *Schistocephalus* sp., was common in Pine Lake specimens. In a few male specimens from Pine Lake and Salt River the ventral surface under the pectoral fins was jet black, indicative of breeding conditions.

The sticklebacks in Fox Holes Lake are of particular interest because of the shallow depth of the habitat and their relatively small size (the two largest specimens are 47 and 51 mm standard length, all others are less than 42 mm). These lakes consist of several ponds, some of which are connected by a small channel. Two of the major ponds collected had small areas with a maximum depth of about 24 and 32 inches (61 and 81 cm). The depth of the largest area, by visual inspection, was only about 8 inches (20 cm).

Percopsidae

TROUT-PERCH — *Percopsis omiscomaycus*. Map number — 18.

This species was taken only in the muddy waters of the Peace River, both at Peace Point and downstream near Carlson Landing (not shown on Figure 1).

Percidae

IOWA DARTER — *Etheostoma exile*. Map number — 14.

The Iowa darters in Pine Lake are of particular interest; they represent the northernmost known population for the species. Only a few records exist for the Peace-Athabasca drainage to the south with continuous distribution starting only in the Lac La Biche — Cold Lake area about 330 miles (531 km) to the south. Individuals are common in Pine Lake; 60 specimens were taken in a few short seine hauls in 1971.

WALLEYE — *Stizostedion vitreum*. Map numbers — 10 and 15.

Walleye, along with northern pike, make up a sport fishery on Salt River and like the northern pike are absent from the landlocked lakes we sampled.

Cottidae

SPOONHEAD SCULPIN — *Cottus ricei*. Map numbers — 8,9,10, and 18.

Spoonhead sculpins were common in parts of Salt River. At one site (locality 9), 58 specimens were collected in a small area of boulders at an old bridge site. It was also taken in the Peace River at Peace Point and in limited collecting in the Slave River.

Other Species

Several other species are known from the study area but were not collected by us. Arctic lamprey *(Lampetra japonica)* are known from the mouth of the Salt River (60°06′; 112°14′) and have been collected from the water treatment plant of Fort Smith, part way up Rapids of the Drowned. The Alberta border is about one mile from the latter site and we see no reason to believe that the adults of the species might not occasionally get into Alberta. Three specimens of chum salmon *(Oncorhynchus keta)*, have been obtained by Dr. N. S. Novakowski from the foot of the Rapids of the Drowned at Fort Smith. Brook trout *(Salvelinus fontinalis)* were stocked in Seven Mile Lake (60°00′; 112°38′) in 1949 and later stocked in Pine Lake (they were restocked in Pine Lake in 1971 but we did not collect any specimens). Cutthroat trout *(Salmo clarki)*, splake *(Salvelinus fontinalis* x *S. namaycush)*, and brook trout were introduced separately into three of the five Rainbow lakes in 1964 (pers. comm., N. S. Novakowski). Splake were also introduced into Pine Lake (first in 1961) where good growth was evident. One angled individual measured 29.7 inches (75.5 cm) fork length (pers. comm., Mr. E. Kuyt). Introductions of rainbow trout have already been mentioned. There is no evidence of reproduction in any of the introduced salmonids. Goldeye *(Hiodon alosoides)* and inconnu *(Stenodus leucichthys)* are commonly caught at the mouth of Salt River and below Rapids of the Drowned (pers. comm., W. Johnson and E. Kuyt). Goldeye are common in tributaries to the south and inconnu, which also ascend the Buffalo River, might occasionally get

TABLE 1. — Localities from which fish were collected. WBNP = Wood Buffalo National Park, NWT = Northwest Territories. Number of species excludes introduced salmonids.

Map number	Locality	Approximate latitude and longitude	Number of species
1	Klewi River – WBNP, NWT	60°11′; 113°42′	2
2	Sass River – WBNP, NWT	60°04′; 113°18′	7
3	Preble Creek – WBNP, NWT	60°02′; 113°12′	8
4	Unnamed ditch – WBNP, NWT	60°02′; 112°56′	1
5	Little Buffalo River – border of WBNP, NWT	60°03′; 112°47′	7
6	Fox Holes Lake – NWT	60°04′; 112°28′	1
7	Salt River – NWT	60°05′; 112°15′	3
8	Salt River – NWT	60°01′; 112°21′	4
9	Salt River – border of WBNP, Alberta	59°58′; 112°24′	4
10	Salt River and Brine Creek – WBNP, Alberta	59°57′; 112°17′	8
11	Salt River – border of WBNP, Alberta	59°49′; 111°57′	3
12	Rainbow Lake number 4 – WBNP, Alberta	59°47′; 112°11′	1
13	Rainbow Lake number 1 – WBNP, Alberta	59°47′; 112°10′	3
14	Pine Lake – WBNP, Alberta	59°33′; 112°15′	4
15	Unnamed creek – WBNP, Alberta	59°39′; 111°29′	5
16	Unnamed creek – WBNP, Alberta	59°38′; 111°29′	3
17	Hornaday River – WBNP, Alberta	59°26′; 111°30′	5
18	Peace River – WBNP, Alberta	59°07′; 112°27′	6
19	Unnamed creek – WBNP, Alberta	59°07′; 112°04′	1
20	Unnamed creek – WBNP, Alberta	59°07′; 112°03′	2

into Alberta. McPhail and Lindsey (1970) record round whitefish *(Prosopium cylindraceum)* from the Slave River near Fort Smith; to the south it is present in the Saskatchewan portion of Lake Athabasca.

Discussion and Conclusions

Within the Yukon and Northwest Territories several species have their known southern distributional limits near Fort Smith in the Slave River, namely Arctic lamprey, inconnu, and chum salmon. They are relatively large anadromous fish and they share their environment with predatory fish (northern pike, burbot, and walleye). Several species have their northernmost range limits in the Fort Smith region, namely, northern redbelly dace, fathead minnow, pearl dace, brook stickleback, and Iowa

TABLE 2. Chemical analysis of water from systems from which we have fish. Total dissolved solids were obtained by evaporating a filtered water sample at 110°C, pH was measured in the field with a Beckman portable pH meter. Data obtained from detailed study of Dr. R. Green.

Location	Approximate lat. and long.	pH	Total dissolved solids (ppm)	Major anion (ppm)	Major cation (ppm)
Klewi River	60°11′; 113°42′	7.9	944	SO_4–481	Ca–204
Sass River	60°04′; 113°18′	7.9	1150	SO_4–681	Ca–295
Preble Creek	60°02′; 113°12′	8.0	1416	SO_4–727	Ca–315
Little Buffalo River	60°03′; 112°47′	8.0	432	SO_4–164	Ca–83
Salt River	59°56′; 112°16′	8.7	4428	Cl–2140	Na–1338
Salt River	59°49′; 111°57′	8.4	3072	Cl–1550	Na–894
Salt River	59°35′; 112°17′	7.6	232	HCO_3–164	Ca–51
Brine Creek	59°54′; 112°13′	8.7	6588	Cl–2870	Na–1794
Brine Creek	59°51′; 112°05′	8.2	10780	Cl–4975	Na–3050
Rainbow Lake	59°47′; 112°10′	8.0	256	HCO_3–185	Mg–27
Hornaday River	59°26′; 111°30′	8.2	952	SO_4–224	Ca–130

TABLE 3. — Chemical analysis of water samples obtained by us in 1971. Total dissolved solids were obtained by evaporating a filtered water sample at 105°C.

Locality	Total dissolved solids (ppm)	Cl (ppm)	SO_4 (ppm)	Total hardness (ppm)	Total alkalinity (ppm)
Nylaring Warden Station sinkhole	200	7	45	150	59
Salt River, Site 9	8,168	2925	1500	1516	96
Salt River, Site 10	9,096	3938	1450	1532	66
Fox Holes Lake	4,530	605	2050	1528	52

darter. However, unlike the "northern" fish these are small fish occurring in landlocked lakes or small creeks which generally lack predatory fish. Strangely, the "southern" fish are locally very abundant in some localities in contrast to species which have a far wider range in the north, namely, lake chub, flathead chub, longnose dace, and longnose sucker. Minnows (cyprinids) are so common in one tributary of Little Buffalo River, Sucker Creek, that in the past they have formed a winter fishery for dogfood. The five fish that are so common south

TABLE 4. — Completeness of the pelvic skeleton in the sticklebacks.

Species	Year of collection	Locality	Pelvic skeleton state: absent	Partly developed: no spines	Partly developed: one spine	complete	Total
C. inconstans	1970	Klewi River	–	–	–	61	61
	1970	Sass River	1	–	–	31	32
	1970	Preble Creek	1	–	–	104	105
	1971	Ditch, Map No. 4	–	–	–	4	4
	1971	Little Buffalo River	–	–	–	30	30
	1970	Salt River, Map No. 8	–	–	–	57	57
	1971	Salt River, Map No. 9	–	–	–	2	2
	1970	Salt River, Map No. 10	–	–	–	10	10
	1971	Salt River, Map No. 10	–	1	1	25	27
	1970	Rainbow Lake No. 1	23	–	–	1	24
	1971	Rainbow Lake No. 1	72	–	–	–	72
	1971	Rainbow Lake No. 4	30	–	–	–	30
	1971	Pine Lake	3	–	–	–	3
	1971	Map No. 19	–	–	–	8	8
	1971	Map No. 20	–	–	–	6	6
P. pungitius	1970	Fox Holes Lake	142	–	–	–	142
	1971	Fox Holes Lake	503	8	1	–	512
	1971	Salt River, Map No. 7	15	2	6	51	74
	1970	Salt River, Map No. 8	2	–	–	34	36
	1971	Salt River, Map No. 9	1	1	2	3	7
	1970	Salt River, Map No. 10	16	21	11	94	142
	1971	Salt River, Map No. 10	29	35	40	117	221
	1970	Salt River, Map No. 11	–	–	–	27	27
	1971	Salt River, Map No. 11	20	89	47	248	404
	1970	Pine Lake	70	396	245	1275	1986
	1971	Pine Lake	1	5	2	10	18

and west of Fort Smith are relatively sparse in much of northern Alberta (Paetz and Nelson, 1970). Furthermore, none of them is noted in Saskatchewan in the headwater drainage of Lake Athabasca (Johnson, 1971). The slimy sculpin *(Cottus cognatus)* might be expected in the study area since it is widespread in northern Alberta and the Northwest Territories, yet it is the somewhat rarer spoonhead sculpin that is present. Several species are known to the south and north of the study area and yet were not found by us nor are they definitely reported by Mr. E. Kuyt. They include lake whitefish *(Coregonus clupeaformis)*, cisco *(C. artedii)*, Arctic grayling *(Thymallus arcticus)*, and yellow perch *(Perca flavescens)*. Several of these, including the slimy sculpin, occur in the province east of the Slave River, in the Precambrian Shield.

That the study area is indeed unique seems beyond doubt. We can think of no other area in Alberta which presents a similar problem. Needless to say, we cannot discount the possibility that future collecting will show some of the species to be more widespread than is now known.

We do not speculate at this time on why several species are unusually abundant at their known northern range limits, in the Fort Smith area. To what extent abundance is related to the unusual habitat and lack of predators or large fish in the sinkholes we do not know. Little can be said on the possibility of underground movement through karst channels from sinkhole to sinkhole. This may be the most probable means of dispersal. A post-glacial lake did exist in Peace-Slave River to Pine Lake area (pers. comm., Dr. L. A. Bayrock) but we do not know if fish had access to this lake early enough to inhabit it.

The study area is also of much interest because the two species of stickleback in some localities fail to develop the pelvic skeleton. In Fox Holes Lake in large samples not one specimen was collected with a complete skeleton. The only other area where ninespine sticklebacks fail to develop the pelvis is in Ireland (Nelson, 1971) while the brook stickleback exhibits the same phenomenon in central Alberta and Saskatchewan (Nelson and Atton, 1970).

The unusual fish fauna in an area with relatively high salinity streams and karst topography warrants further study and safeguards to the native fishes. Our studies continue.

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Natural History of a Manitoba Population of Franklin's Ground Squirrels

STUART L. IVERSON
BRIAN N. TURNER

Environmental Control Section, Whiteshell Nuclear Research Establishment
Atomic Energy of Canada Limited, Pinawa, Manitoba

Abstract. Franklin's ground squirrels (*Spermophilus franklinii* Sabine), resident on the same old-field as a population of meadow voles (*Microtus pennsylvanicus*), were observed for a period of 5 years. Adult males emerged from hibernation as early as mid-April, followed by adult females in early May. Both sexes appeared capable of reproduction upon emergence. The single litter ($\bar{x} = 9.4$ young) was born during June, and the adults were out of breeding condition shortly thereafter. Young squirrels did not reproduce in their first summer. Weight gains of adults occurred until mid-August, when the first adults entered hibernation. Young gained weight through September and some remained active until early October. Males moved greater distances than females, both sexes centering their activity in disturbed areas. Overwinter survival ranged from 20% to 60%. Stomach contents did not contain mammalian material, although captive squirrels readily killed and ate meadow voles and laboratory mice (*Mus*). It was concluded the ground squirrels probably had little effect as a predator on the vole population.

Introduction

During a demographic study of a meadow vole (*Microtus pennsylvanicus*) population, juvenile Franklin's ground squirrels (*Spermophilus franklinii* Sabine) were observed in the area. Since mice form part of its diet in Manitoba (Sowls, 1948), the ground squirrels were a potential vole predator. Investigation of this influence involved intensive live and kill trapping of the squirrel population. The life history information presented here is a synthesis of data collected during 1967-1971.

Materials and Methods

The study area is situated on an old-field at the Whiteshell Nuclear Research Establishment, 75 miles northeast of Winnipeg. The field was cleared of young aspen (*Populus tremuloides*) in 1956, planted in wheat for the next 4 years, then abandoned in 1960 after being sown with red clover (*Trifolium pratense*). Franklin ground squirrels since that time have established their burrow systems in 6 disturbed areas (Fig. 1) resulting from gravel exploration.

Dominant vegetation in the old-field included brome grass (*Bromus inermis*), Kentucky blue grass (*Poa pratensis*), timothy (*Phleum pratense*), sedge (*Carex* spp.), strawberry (*Fragaria virginiana*), sweet clover (*Melilotus alba*), clover (*Trifolium* spp.), goldenrod (*Solidago* spp.) and dandelion (*Taraxacum officinale*). Willows (*Salix* spp.) were invading the periphery of the clearing. A more complete description of the old-field is given in Turner, Iverson and Walley (1972).

The first live ground squirrels caught (1968) were juveniles which entered Longworth traps set for voles. In 1969, 1970 and 1971, 1.25 and 2.5 cm mesh traps (46 cm × 15 cm × 15 cm) were set on a non-standardized rotational basis at all areas where ground squirrel activity was seen, and to a lesser extent, between these areas. These areas were located during a spring survey of the field, before burrow entrances were hidden by vegetation.

Traps were baited with lettuce, oats and carrots, and covered with grass to provide shade. They were left set between approximately 0900 and 1600 hours, except immediately after the release of a squirrel, so that retrapping the same day would not occur. Occasionally traps were set between 1700 and 0800 hours but evening captures were rare. Animals were taken to a field laboratory where unmarked squirrels were marked individually by toe-clipping, and the sex, reproductive condition, weight and capture location were recorded. Squirrels were released at point of capture, generally within 2 hours of their discovery.

Internal reproductive and dietary data were recorded from 16 squirrels taken in Conibear

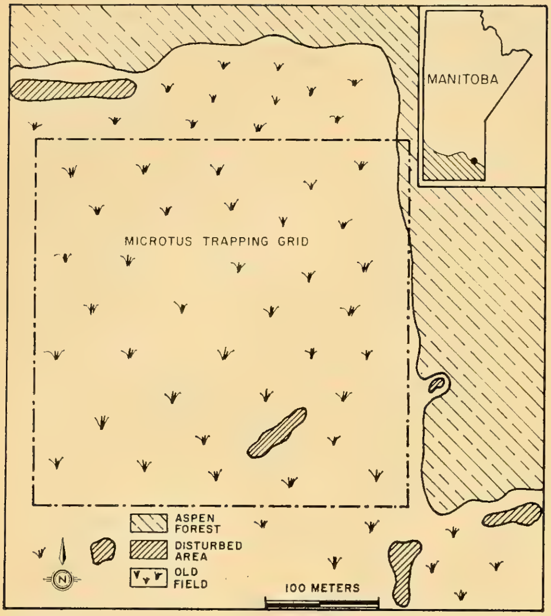

FIGURE 1. Plan of the trapping area. Hatched part of inset map shows distribution of *S. franklinii* in Manitoba (Hall and Kelson, 1959), and circle indicates study location.

traps set in a disturbed area southwest of the main old-field habitat. These data were supplemented by 31 captures in Museum Special traps set in sampling lines (Adam and Iverson, 1968).

Results and Discussion

Emergence from hibernation

First spring capture dates (1969:2 May; 1970:8 May; 1971:11 May) may be related to changing soil temperatures. In all three years, the earliest capture was in the week in which mean soil temperature at 200 cm increased after its winter minimum (A. Reimer, personal communication). However, infrequent periods of arousal could provide the squirrel with an opportunity to sense whether the shallower tunnels had become warmer than the hibernation chamber. Although photoperiod cues (Pengelley and Fisher, 1963; Pengelley and Asmundson, 1971) are undoubtedly important in this animal, the time of onset of spring is variable and soil warming may be a more accessible and valuable cue to begin above ground activity.

Reproduction

A synthesis of 5 years of reproductive data (Table I) indicates adult males are capable of breeding as soon as they emerge from hibernation. Testis lengths during May ranged from 18 to 23 mm, all animals had scrotal testes, and sperm were present in all epididymides examined. By 24 June, testis length had regressed to 13 mm but sperm were still present. Testis position of young males was difficult to classify but lengths of testes never exceeded 7 mm, and none had sperm in the epididymides. Although adult males had scrotal testes until the third week of July and some young males were classified as having scrotal testes, testis length and sperm examinations are a more reliable method of distinguishing reproductive capability.

Adult females had perforate vaginas upon emergence, but since first female captures were later than for males in all years, onset of breeding is apparently dependent on emergence time of the females, as suggested by Sowls (1948). Our data generally agree with Sowls (1948) who noted that the breeding season at Delta, Manitoba terminated by the beginning of June. Reproductive capacity, determined by litter, embryo or placental scar counts, ranged from 2 to 13, the mean of 9.4 and the upper limit of 13 both being greater than previously reported for Franklin's ground squirrels (Sowls, 1948). Mean litter size was 7.5, ranging from 5 to 11, at Delta (Sowls, 1948), whereas samples from North Dakota (Bailey, 1927), Indiana (Lyon, 1932), Wisconsin (Jackson, 1961) and the Great Lakes (Burt, 1957) had means of approximately 6, ranging from 4 to 11. No pregnant squirrels were captured after 20 June, although 2 females brought into the laboratory bore 10 young each, on 9 and 24 June respectively. Placental scars were noted as early as 5 June. Presence of evident nipples was used as an indicator of lactation, the period terminating in late July. Data support Sowls (1948) in showing that each adult female produces only 1 litter per year. No females showed reproductive capacity during the summer in which they were born.

Total adult sex ratios for 1969 were N = 30, 47 percent males, and for 1970 were N = 17, 59 percent males. For May and June only (the reproductive season), they were N = 19, 53 percent males in 1969, and N = 10, 60 percent males in 1970. In no case did the number of males differ significantly from 50 percent. Percentages during the reproductive season may be misleading, since males emerged earlier, moved over larger areas and were thus more vulnerable to trapping.

Movement

Activity of the ground squirrels, as indicated by trapping, sightings and sign, was primarily in the disturbed areas shown in Fig. 1. Of 37 animals captured 4 or more times, only 3 were not captured in a disturbed area. The squirrels moved between disturbed areas however, and the mean number of areas visited averaged 1.8. Nineteen percent of the animals were trapped at least once in both the isolated disturbed area in the northwest corner of the field and any one of the other areas. The minimum distance one way in this move was 320 m. Movements of sex and age groups were tabulated separately and although the data are too limited to allow comment on differences among groups, it was found that all groups visited more than one disturbed area and made long moves as noted above.

Since few squirrels live in the undisturbed areas but most cross them in going from one area to another, a home range calculated by the usual method would be an exaggeration of the area used by the animal. Jackson (1961) suggests that the home range radius of this animal is approximately 150-200 feet. The area of circles of these radii are 6,644 and 11,689 square meters. Our largest disturbed area is approximately 5,250 square meters, three are between 1,000 and 1,250 and the two smaller ones are less than 600 square meters. Thus, if our squirrels have home ranges as large as those reported by Jackson (1961), significant portions of their ranges must be in the old-field between the disturbed areas.

Seasonal Weight Changes

Hibernating Franklin's ground squirrels subsist on stored fat (Bailey, 1927), and so must both reproduce and lay down fat for the next winter during their 4 to 5 months of activity. The sharp decline in female weights in late May probably indicated occurrence of parturition. Adult weights showed a general increase until mid-August (Fig. 2). The maximum weight of 711 g was similar to that reported

Table 1. — Occurrence of reproductive events and activity above ground 1967–1971.

Sex	Variable	Overwintered adults	Young of year
Females	Active above ground	9 May – 26 Sept.	2 July – 11 Oct.
	Vagina perforate	9 May – 19 June	None
	Pregnant	18 May – 24 June	None
	Placental scars	5 June – ?	None
	Nipples evident	20 May – 24 July	None
	Litter count	(10,10) $\overline{X}$ = 10	None
	Embryo count	(2,9,10,11,11,12,13) $\overline{X}$ = 9.7	None
	Placental scar count	(6,8,9,11) $\overline{X}$ = 8.5	None
Males	Active above ground	2 May – 2 Sept.	10 July – 4 Oct.
	Scrotal testes	2 May – 24 July	see Discussion
	Abdominal testes	14 July – 2 Sept.	see Discussion
	Positive epididymal smear	? – 11 May – 24 June	None
	Testis length	11–27 May, 18–23 mm $\overline{X}$ = 21.3, N = 8 24 June, 13 mm	12 July – 7 Sept. 4–7 mm, $\overline{X}$ = 5.5 N = 11

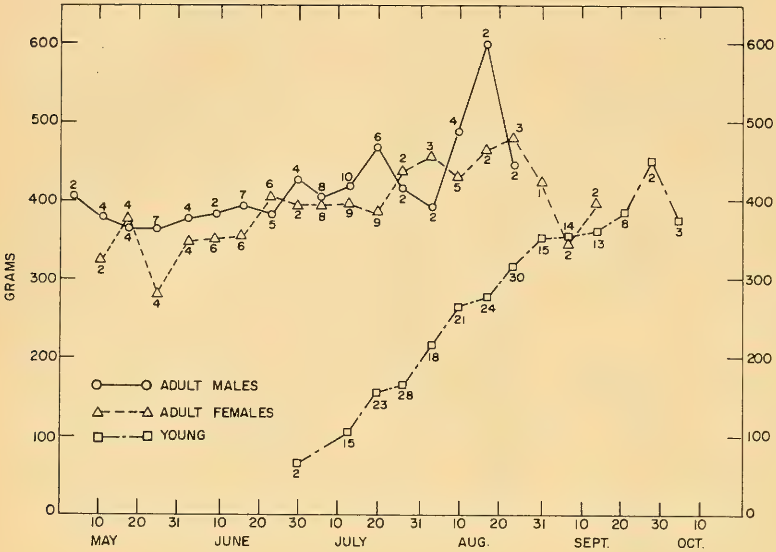

FIGURE 2. Mean weights of adult and young ground squirrels. Sample sizes shown for each point.

from Wisconsin (Jackson, 1961). At that time, adult males became inactive or hibernated and were not caught. Adult females appeared to remain active for up to a month longer, but in both sexes heavy squirrels were seldom caught after the middle of August. Mean adult weights (Fig. 2) for both sexes declined after mid-August, and 3 of 4 individuals caught in September had lost weight from their August peaks.

Young squirrels gained weight faster than adults (Fig. 2) and reached approximately the mean hibernating weight of adult females by mid-September. Young frequently remained active until late September and early October, allowing more time for weight gain.

Regression of weight of young-of-the-year ground squirrels on time showed no significant differences in slope or intercept between the three years (1968, $y = 0.17 \pm 0.02x + 29.43$, $N = 46$, $r = 0.84$; 1969, $y = 0.17 \pm 0.01x + 25.39$, $N = 55$, $r = 0.90$; 1970, $y = 0.15 \pm 0.01x + 37.21$, $N = 44$, $r = 0.89$). The zero intercept for 1969 is about 12 days earlier than 1970, indicating that littering may have occurred earlier that year as had adult emergence. By August however, the weights of all cohorts were very similar.

Food Habits

Stomach contents of 26 ground squirrels were examined. Seven contained animal material, primarily insects, but none contained identifiable mammal material. Vegetative material was present in all, but no identification to species was attempted. Green vegetation is available upon emergence from hibernation but species of vegetation utilized change as summer progresses (Sowls, 1948). Nine young squirrels housed in the laboratory for several months readily killed and ate laboratory mice (*Mus musculus*) and meadow voles offered to them. Although a field collection of fecal pellets did not contain mammal hair or bone, this may be partly explained by the laboratory observation that the skin of mice was not eaten. Thus, our data do not reveal any effect of Franklin's ground squirrels as a predator of voles although Sowls (1948) noted mouse remains in 14 of 178 stomachs examined at Delta, Manitoba.

Overwinter Survival

Overwinter survival was examined by comparing the number of marked individuals released from August to October with those re-captured the following spring (Table II).

Survival varied between 20% and 60%, with no consistent trends between sexes. The apparently higher survival in 1968-69 may reflect more efficient trapping in the spring of 1969 than in 1970. Four of the 7 overwintering males were adults. whereas all females overwintering had been born the previous summer. In all cases, the figures presented are minimal estimates, since some squirrels may have survived the winter but dispersed or were preyed upon before being captured in the spring. Although spring flooding over the trapping area is common, the entrances of squirrel burrows are situated on the inclines of the 1 to 2 m high mounds of the disturbed areas, and have been above all spring water levels observed. The security from spring flooding provided by these mounds may be one of the reasons for homesite, and therefore activity, occurring mainly in the disturbed areas.

In conclusion, the ground squirrel population, though resident in the same area as the voles, probably has little effect as a predator on them. Activity seasons and reproductive data generally concur with Sowl's (1948) results from Delta, Manitoba, except that litter sizes were smaller at Delta. The squirrels appear to center their activities around the disturbed areas in which they hibernate, traversing the main part of the old-field less frequently.

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Some Effects of Water Level on the Reproductive Success of the White Pelican at East Shoal Lake, Manitoba

R. M. Evans

Department of Zoology,
University of Manitoba,
Winnipeg, Manitoba

Abstract. Historical records combined with personal observations from 1967 to 1971 indicate that islands which become unsuitable for breeding due to water level changes may be recolonized when breeding habitat is restored.

Fluctuations in water level have been well documented for prairie lakes (e.g. Taverner, 1919; Nero, 1961; Houston, 1962; Vermeer, 1971). As emphasised by Houston (1962), these fluctuations may pose significant hazards to the reproductive success of island breeding colonial birds, particularly to species such as the White Pelican *(Pelecanus erythrorhynchos)* that typically breed on low lying islands or gravel bars subject to flooding in years of high water. Moreover, when water levels recede, reproductive success of these species may also be threatened when islands become continuous with the mainland and hence exposed to mammalian predation (Raine, 1895; Taverner, 1919; Lawrence, 1943; Nero, 1961; Houston, 1962). Documentation of possible adaptations to this situation, such as rapid recolonization of an area should water levels again become suitable, appears to have received less attention. The present report, which summarizes information from the literature plus my observations of White Pelicans on East Shoal Lake over the past five years (1967-1971), provides further evidence that (1) changes in water levels may be associated with a lack of reproduction in a colony, and (2) a rapid and successful recolonization can occur when the breeding habitat is restored.

Historical Sketch

In 1878, Hunter (*in* Thompson, 1891) counted some 600 pelican eggs on a small island in Shoal Lake. According to Raine (1895), the numbers subsequently declined, although nests were still present at the time of his visit in 1894. Breeding pelicans were still present when the lake was visited by Chapman in 1901 (Chapman, 1908), but by 1917, only occasional small flocks were noted, and apparently no breeding colonies were present (Taverner, 1919). By 1962, however, pelicans were again breeding in this area, on East Shoal Lake (Hosford, 1965).

According to Taverner (1919), pelicans were common breeders on Shoal Lake primarily during periods of high water, which occurred at the time of visits to the lake by Raine in 1894 and by Chapman in 1901. After reaching a peak in 1899 (Ward, cited in Taverner, 1919), lake levels declined some eight to ten feet by the time of Taverner's visit in 1917, when no breeding pelicans were found. While one cannot now trace in detail the changes that this extreme drop in water brought about, it can be inferred from the position of the old shore lines that many of the small ridges and elevations now lying near the lake must have been islands, and hence potential colony sites, in times past. A loss of such traditional breeding sites due to low water levels thus seems the most plausible explanation for the relationship between breeding success and water levels up to the time of Taverner's (1919) report.

Fortunately for the pelican, declining water levels such as that described by Taverner do not normally result only in a *loss* of potential or actual colony sites. The present day existence of low lying rock and gravel islands which would have been completely flooded at times

of higher water indicates that new islands may also be created as the water levels subside. The successful return of breeding pelicans to low lying islands, as reported by Hosford (1965), indicates that such new islands can ultimately form a suitable substrate for successful reproduction.

Recent Trends

More complete records of water levels and pelican breeding at East Shoal Lake are available for the past decade. In 1962, Hosford observed an estimated 300 pairs breeding on a rocky spit that "would have been an island in years of higher water level" (Hosford, 1965: 21). Whether these birds were successful in rearing young despite the connection of the colony to the mainland was not indicated. Pelicans did return to breed again in 1963, however, but this time the colony was completely inundated by rising water resulting from severe storms and heavy rain. No young were produced that year apparently. With a return to lower water levels in 1964, the original island, plus one other nearby, contained breeding colonies of 74 and 212 White Pelican nests respectively (Hosford, 1965).

When I first visited East Shoal Lake on 13 May, 1967, the area thought to be the site of Hosford's Colony A appeared to be incorporated into the mainland, and had no pelicans on it, while the area coinciding with his Colony B was a true island, and contained an active breeding colony of some 365 nests. By 1968, lake levels had declined further. On 24 May, the colony site was observed from a distance with binoculars, and found to be unoccupied by pelicans. The site was then examined at close range, and was found to be essentially part of the mainland, the maximum separation from the latter being a small channel only 3′ to 4′ wide and less than a foot deep. In 1969, water levels of East Shoal Lake were again low as in the preceding year, and no breeding pelicans were noted when the region was visited on 13 May. The results of an aerial census of White Pelican colonies conducted in the same year likewise showed no pelicans breeding in the Shoal Lake region (Vermeer, 1970).

According to various local reports, water levels of the prairie lakes in southern Manitoba were higher in 1970. By walking along the shore to a point opposite the site occupied by pelicans in 1967, I was able to verify that this situation also prevailed at East Shoal Lake. As in 1967, the colony site was again a true island, and appeared to have a full complement of breeding pelicans in residence. To avoid any possible disturbance to this recolonizing population, the island was not visited; hence an accurate estimate of reproductive success could not be obtained that year.

Proof of breeding by pelicans at East Shoal Lake was obtained in 1971, when a total of 328 nests was counted during a brief visit to the colony on 13 May. Inspection of the colony with binoculars from the edge of the island on 16 July indicated that at least 45% of the eggs had survived to produce young of over 1 month of age. The proportion of these young that ultimately fledged could not be determined, but a subsequent inspection of the colony from the mainland on 7 September indicated that a substantial population of young had survived to that time. Water levels in 1971 appeared to be down somewhat from the previous year, but not sufficient to destroy the island status of the colony site.

Discussion

Pelicans and other colonial birds with similar breeding requirements (e.g. Caspian Tern, *Hydroprogne caspia;* Doubled-crested Cormorant, *Phalacrocorax auritus;* see e.g. Evans *et. al.,* 1970), have presumably been subjected for ages past to losses and gains in suitable breeding habitat resulting from water level fluctuations. It is therefore not surprising that they appear to exhibit important adaptations permitting survival under these conditions. In particular, the capacity, potentially at least, to recolonize regions or even specific colony sites should these become suitable again after a period of flooding or attachment to the mainland would appear to be of major importance

in enabling these species to survive under natural prairie conditions. Indeed, it might well be supposed that fluctuations in water level are of major long-term advantage to the species, in that periodic high water levels would assure that trees and other large vegetation would not gain a foothold and thereby destroy the suitability of low lying islands as potential breeding sites. With a return to lower levels, breeding on the previously denuded islands could presumably occur.

Clearly, more extensive surveys over the long-term are required to assess the validity of the above hypothesis. In the meantime, it is to be hoped that sufficient concern will be shown quickly enough to assure that depredations by man, whether of the birds themselves, their eggs, or their delicate habitats, will not cause irreparable damage to these colonial nesting birds before sufficient knowledge and resources are acquired to assure their perpetuation throughout the prairie region.

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ROGER M. EVANS

Department of Zoology,
University of Manitoba,
Winnipeg 19, Manitoba.

Notes on Habitat Preference and Reproduction in Pigmy Shrews, *Microsorex*

CHARLES A. LONG

Museum of Natural History and Department of Biology, Wisconsin State University, Stevens Point, Wisconsin

Abstract. Records on habitats of pigmy shrews are reviewed, and new records from Wisconsin habitats and from specimen labels of the genus are presented. *Microsorex* may occur, seasonally at least, on dry soils, but usually fairly close to boreal mesic habitats. New reproductive records are presented, as is a second record of predation.

The boreal pigmy shrews, *Microsorex,* are among the rarest of mammals (Anthony, 1928). *Microsorex* have been reported as belonging to disjunct populations, but Long (1972) found the range of the seven subspecies generally continuous (except *M. hoyi montanus*). Habitats are recorded as decidedly wet and definitely dry. Specimens of *Microsorex* now number several hundred, yet little is known of their autecology. In *M. h. alnorum* and *M. h. montanus* water or can traps have provided detailed ecological descriptions of several local habitats (Prince, 1941; Spencer and Pettus, 1966). The following notes on habitats and reproduction are based on a review of scattered notes in the literature, on my survey of meagre information from a majority (250) of specimens known to science, and on 29 pigmy shrews recently obtained by my students and myself from habitats of central and northern Wisconsin.

Records of Habitats

Microsorex h. hoyi: In Clark County, Wisconsin, Schmidt (1931) caught a pigmy shrew in a hemlock forest under a rotten log, on Chelsea clay loam. Three were trapped in hardwoods on Colby loamy clay. One was caught on Mentor loamy sand in dense white pine, and another in poplar (aspen), soft maple, jack pine, and sweet fern at the base of a sandstone buttē. Quimby (1943) obtained a specimen at Itasca Park, Minnesota, in a "marshy area adjacent to a small stream." B. Bailey (1929) reported this shrew in Minnesota from "cold sphagnum" in a tamarack swamp, and also from heavy grass at the edge of a "rice" lake. Buckner (1966) recorded pigmy shrews in southeast Manitoba as "rare bog inhabitants." Plant indicators were black spruce, tamarack, *Ledum groenlandicum, Betula glandulosa,* and sphagnum. The water table varied from deep to shallow. Cahn (1937) mentioned that pigmy shrews near lakes in Quetico Provincial Park, Ontario, preferred open woods, living under logs and stumps, and avoided swampy and other wet areas and rocky places. In Iowa, Scott (1939) reported *Microsorex* from dense bluegrass in a wet pasture adjacent to a lake. Findley (1956) caught a pigmy shrew on the Great Plains of South Dakota, in a "cattail-rush community on the edge of a slough." Habitats on the Gaspé Peninsula, ascribed now to the geographic range of *M. h. hoyi,* were described by Goodwin (1924, 1929), who caught one shrew in the forest in the runway of a red-backed vole (*Clethrionomys gapperi*) and obtained several from a sheltered valley in a habitat characterized by driftwood. He described the terrain as dry, open country. In southern Quebec, Wrigley (1969) caught one in "a damp, white spruce stand several yards from an alder-lined stream" and another in a sphagnum bog.

Microsorex h. washingtoni: Koford (1938) found this shrew in Montana about 100 feet from the Thompson River, in a place with little undergrowth surrounded by open forest of second growth ponderosa pine, western larch (*Larix occidentalis*) and Douglas fir (*Pseudotsuga*). Brown (1967) quoted remarks of Conaway, who trapped this subspecies in northwest Montana, in clearcut forest having dense vegetation on the ground.

Microsorex h. montanus: Spencer and Pettus (1966) obtained pigmy shrews in western Larimer County, Colorado, 9700 feet elevation, mostly in the habitat between marsh and forest, and with high frequency in the forest and occasionally in meadow, clearcut areas and marsh. They suggested that this species requires both forest and marsh. Plant indicators were *Carex, Calamagrostis, Salix,* sphagnum, lodgepole pine, and climax spruce and fir, with *Vaccinium* on the forest floor. Plants recorded from a nearby Wyoming locality (Brown, 1966) include alpine fir and Engelmann spruce. Other mammals taken there were *Clethrionomys gapperi, Microtus montanus, Sorex cinereus,* and *S. vagrans.* The wood frog *(Rana sylvatica)* and boreal cricket frog *(Pseudacris triseriata)* were abundant in these habitats.

Microsorex h. eximius: In Alaska, this supspecies inhabits the interior forests (Long, 1972), and I know of no careful description of its habitats. Dice (1921) reported the species active in winter, taken from a tiny runway in snow, and Preble (1908) trapped it in "damp places" with *Microtus* and *Sorex cinereus.*

Microsorex h. alnorum: Preble (1902) caught the holotype at Robinson Portage, Keewatin. Prince (1941) described two habitats of specimens now ascribed to *alnorum* (see Long, 1972) as "a dry, high-grass clearing, bordering second growth alder-poplar-birch woods," and "the alder-birch-poplar-dogwood border of Lake Attawapiskat." The ground was dry with little brush. One specimen was taken in a wet sphagnum bog bordering a black spruce woods. Harper (1961) described the habitat of a pigmy shrew tentatively assigned to *alnorum* as an "open bog, grown with moss, sedge, white spruces, dwarf birch, sweet gale, *Habenaria,* and *Equisetum.*"

Microsorex thompsoni thompsoni: If Saunder's (1929) shrew was a *Microsorex,* then this shrew from New York was taken about 100 yards from a small stream. Miller (1964) reported the pigmy shrew in Vermont from subclimax beech-maple forest with an almost closed canopy, excepting small clearings, with plant indicators of sugar and mountain maples, *Prunus* (chokecherry), *Viburnum,* sedges, and ferns. Manville (1942) noted that this shrew occurs in heavy spruce and pine woods bordering a lake on Mount Desert Island, Maine. Heinrich (1953) took it on a mountain associated with mats of mosses under low, creeping spruce bushes in the "upper dwarf woods."

Microsorex t. winnemana: Preble (1910) reported this shrew from within a decayed log on the bank of the Potomac River, near Stubblefield Falls, Virginia, evidently in moist forest of maple and other deciduous trees (Jackson, 1928:4). Another specimen was taken at Berwyn, Maryland, in the "decayed heart of a dead chestnut tree . . . from a dry hillside at some distance from water." Jackson (1928:5) quoted a letter by G. W. J. Blume, stating that a pigmy shrew from Alta Vista, Virginia, was found in "dry, wooded land, probably not over 100 yards from running water . . . natural concealment afforded by the leaves, rocks, old logs, etc. in the vicinity." Wharton (1968) ascribed northern hardwood forest habitat to this subspecies. He noted that the pigmy shrews in Georgia inhabit a steep, north exposure characterized by rock outcrops and small cliffs, about 100 yards from a small stream, where trees had been logged. He mentioned yellow and black birches, lindon, hemlock, and rhododendron. Other mammals were *Sorex fumeus, S. cinereus, Blarina brevicauda, Peromyscus maniculatus, Napeozapus insignis,* and *Clethrionomys gapperi.*

New records: It is possible to add a few comments on habitats from pigmy shrews *(M. h. hoyi)* obtained from wet and wet-dry habitats from central Wisconsin (Long, 1970), and data from specimen labels of *Microsorex* examined in the course of a taxonomic study (Long, 1972).

A shrew obtained in September near Polonia was caught by a cat in a driveway on relatively high ground between a marsh and lake. White birch was abundant both on the high ground and in the marsh. One pigmy shrew was found

dead on the road in the vast marsh at the Meade Wildlife Area, Wood County, Wisconsin.

James Fitzpatrick caught a specimen on 7 March 1969, at 3 mi. E. Stevens Point, in an oak-hazelnut *(Quercus-Corylus)* brushy habitat, where the soil was dry and sandy. The snow was three feet deep where the pigmy shrew was trapped. Also taken that day was *Peromyscus maniculatus bairdii* (a prairies species). *P. leucopus, Sorex cinereus, Blarina brevicauda,* and *Clethrionomys gapperi* were taken at this locality that week. Fitzpatrick's field journal reveals an important point: The 40-acre trapping area had "several types of habitat ranging from scrub oak to marsh." Subsequent collecting with can traps has yielded four pigmy shrews, and the following associates were noted: breeding wood duck and partridge, garter snake, American toad, wood frog, dogwood *(Cornus),* serviceberry, spiderwort, swamp bluegrass *(Poa), ferns* (*Osmunda, Dryopteris*), iris, aspen, *Rubus,* Jackpine, choke and black cherry. Willow, alder, and grasses were abundant in the marsh.

In spring, 1971, the low area was wet, and two *Microsorex* and numerous masked shrews were taken there. However, in late August in the low areas, which had dried up, a can grid yielded no pigmy shrews. In early September can traps were emplaced ten yards apart along lines through four types of habitats: Ten in wet marsh, ten in wet woods, 35 in the dry marsh, and ten along the dry wooded ridge. The plants present on the ridge were fruiting cherries and blackberries, grasses, jack pine, and hazelnut. The soil was clean sand under one inch of sandy loam. Wood frogs and mole crickets were found in the cans. The grids were checked daily for one week; by then two *Microsorex* were trapped and the cans were removed because the species is rare. The results were as follows: Dry marsh, 2 *Sorex cinereus;* wet marsh, 5 *Sorex cinereus* and four *Blarina;* wet woods, 3 *Sorex cinereus;* and dry upland woods 40 yards from dry marsh, 3 *Sorex cinereus* and 2 *Microsorex hoyi.* These findings suggest that in the spring *Microsorex* occurs in the wet marsh, but as the populations build up by late summer pigmy shrews and some masked shrews occupy peripheral, dryer habitats.

In late July and early August of 1971, Dr. C. M. White and his students trapped 22 pigmy shrews, and 82 masked shrews from mesic maple-basswood forest and a cleared area at Chippewa Lake, Bayfield Co., in northern Wisconsin. *Napeozapus, Zapus, Eutamias, Peromyscus maniculatus gracilis* and *Clethrionomys* were associates. Most of these shrews were taken at the edge between the forest and dense raspberries; birch, balsam fir, and standing water were only 20-50 yards away.

In 1958, C. Novotny censused the Jordan Pond Cedar Swamp in the winter, trapping such mammals as *Microsorex, Sorex cinereus, S. arcticus, Blarina brevicauda, Reithrodontomys megalotis, Microtus pennsylvanicus, Clethrionomys gapperi* and *Zapus hudsonius.* Subsequent collecting has yielded *Napeozapus insignis, Lepus americanus, Lynx rufus,* and *Sorex palustris.* Novotny obtained about 25 *Sorex* and a single pigmy shrew. This area is swampy and marshy, although distinct prairie-like conditions are close at hand. Plant indicators are tamarack (*Larix*), black spruce, hemlock (*Tsuga*), white cedar (*Thuja occidentalis*), American elm (*Ulmus*), willow (*Salix*), jewel weed (*Impatiens*), iris, marsh grasses, aspen (*Populus*), *paper birch* (*Betula*), alder (*Alnus*), reed canary-grass (*Phalaris*), sedges (*Carex*), *and goldenrod* (*Solidago*).

Two specimens of *M. h. hoyi* from southwest Ontario borowed from the Royal Museum of Ontario, and one from Millston, Wisconsin, from the University of Wisconsin Zoology Museum were taken in mesic communities. Specimen No. 29.9.9.350, was captured along the shore of Off Lake, in black ash (*Fraximus*) and willow (*Salix*). Another (29.9.9.351) was caught in the daytime at stumps in damp mosses under birch saplings at the edge of a "spruce bog." The Millston specimen (UW 10147) was taken in a "sphagnum bog."

Some National Museum of Canada specimens of *M. h. hoyi,* from Pancake River and Bay, have ecological information on their labels. Specimens 13121, 13129, 13115, and

12832 were taken by a stream, the first in cedar and birch, the second in cedar and alders, the third between ridges covered with hardwoods, and the last, "under alders at root of birch — cedar and spruce nearby." Two specimens were trapped at the edge of the River, one of them on sand under alders (No. 12943). No. 13160 was trapped in shallow water, in sphagnum, under "dense second growth cedar."

Specimens of *M. t. thompsoni* from Nova Scotia (NMC 36237) and New Brunswick (NMC 16476) were taken in "mature woods; mixed hardwood, conifer" and in a small clearing in birch and maple, near the top of a small mountain on "dry" soil, respectively.

A specimen from the National Museum of Canada (37029) from Blue Sea Lake, Quebec, was taken from the "stomach of *Buteo delawareness*." Cahn (1937) reported a specimen from the stomach of a garter snake (*Thamnophis*).

Pigmy shrews are frequently taken on snow. Snow cover in the habitats of *Microsorex* varies in depth from a few inches to a few feet (Long, 1970). The ground is covered with snow from November to May in Colorado (Spencer and Pettus, 1966), about late December to March in central Wisconsin, and only for a few weeks in the range of *M. t. winnemana*. Frost may penetrate the soil five feet in Wisconsin (Long, 1970), and of course deeper in northern Canada.

Reproduction

Hamilton (1943) *suggested* that the pigmy shrew has several litters in spring and summer, five to six young in each. Scott (1939) reported seven fetuses in a female from Iowa. Embryo counts and notes on lactation for specimens I have examined, and Scott's record, are as follows:

Microsorex h. hoyi: Mud Lake and Dewey's Pasture, Iowa, respectively, are seven embryos (in one horn), 6.7 mm., in July, and eight embryos, 19 July. One specimen from Millston, Wisconsin was lactating on 28 July. Of 22 *Microsorex* from Chippewa Lake, northern Wisconsin none was pregnant, but one female was lactating (on August 6). Some of these August shrews were young of the year.

Microsorex h. eximius: A lactating female from Chalitna River, Alaska, was taken on 19 August.

Microsorex h. montanus: An alcoholic specimen from 2 mi. S. Chambers Lake, Sec. 18, T7N, R75W west of Fort Collins, Colorado, contained five embryos on 17 July 1962. Another was lactating 26 August 1962. The six nipples are inguinal, with a high posteriormost pair approaching the level of the base of the tail. A juvenile was taken in a can trap in Albany Co., Wyoming, on 30 July.

Microsorex h. washingtoni: One female from Yellow Bay, Lake Co., Montana, was pregnant (three embryos) on 9 August, and another was lactating then.

Microsorex t. thompsoni: Two specimens in the National Museum of Canada from Nova Scotia were lactating and probably lactating respectively on 2 July and 13 June.

Preble (1908:249) described lateral glands about 9 mm. in length, marked by short silvery hairs, on males of *eximius* in summer. Schmidt (1931) reported that these glands in *hoyi* produce a viscous, odiferous substance, and Jackson (1928) reported that these glands are seen in *Sorex* in breeding males. Long (1972) reported these glands as follows: In *eximius*, April; in *alnorum*, July; in *hoyi*, June through August, and in *winnemena* as late as September.

Summary and Conclusions

The *Microsorex* occur as far north as Alaska and Hudson Bay, and occur in cool montane habitats in the Front Range of Colorado and on hills and in riparian communities in and near the Appalachians as far as northern Georgia. Probably the southern populations are relicts from a time when boreal habitats were farther southward. Fossil and subfossil records are in middle Pleistocene (Kansas), late

Pleistocene (Arkansas), and prehistoric time (southern Illinois). All these records are south of the range of Recent pigmy shrews (Long, 1972).

Most habitats of *Microsorex* definitely include water, at least in close proximity. Spencer and Pettus (1966) obtained numerous pigmy shrews from Larimer County, Colorado, showing that the pigmy shrew was relatively abundant between a marshy bog and the forest. In central Wisconsin, shrews were taken in decidedly wet-dry habitats. At all five localities of nine shrews collected, water was only a few yards away, except in autumn and winter. The majority of plant indicators summarized above indicate mesic forest, lakes, bogs, swamps, or marshes. Occasionally a pigmy shrew has been taken in dry clearing, meadow, sand dunes and hilltops, but usually 100 yards or so from water.

The substrates of the pigmy shrews include snow, humus, peaty mud, gravel, stream soils, sandy loam, loamy clay, and mats of moss around bogs or on the forest floor, occasionally sand, and even sod. Undergrowth of ferns, mosses, grasses, bushes, brush, blueberry, raspberry, and even bluegrass have been noted, and logs and stumps have been abundant at numerous trapping sites. In fact, disturbance indicated by logging, floods, and sandy blowouts often seems associated with the presence of *Microsorex*. The pigmy shrew is often taken in seral (aspen, birch, blackberry, raspberry, chokecherry, ponderosa pine) stands.

Hardly anything is known about reproduction in pigmy shrews. New though scanty data on embryo counts and other reproductive information are summarized, suggesting that *Microsorex* do not have several litters per year, only one in *M. h. hoyi.*

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Notes

Reflowering in some Tundra Plants in October near Nome, Alaska

Abstract. *Cassiope tetragona, Empetrum nigrum* and *Salix alaxensis* reflowered after a period of unseasonably warm weather in October 1969. Several plants that normally flower before these species in the spring did not initiate flowering.

Nome, latitude 64° 30′ N, longitude 165° 30′ W, is considered in the Arctic zone by both Porsild (1951) and Polunin (1955) as the climate and vegetation is influenced by its proximity to the Bering Straits. The western limit of treeline on the Seward Peninsula is near Council approximately 60 miles to the east. The vegetation on most of the hills on the western Seward Peninsula consists primarily of dwarf shrub-lichens on the slopes and *Dryas* fell-fields on the summits. The principal species in the dwarf shrub-lichen type are bog blueberry (*Vaccinium uliginosum*), dwarf birch (*Betula nana*) crowberry (*Empetrum nigrum*), Labrador tea (*Ledum decumbens*) and the lichens, *Cladonia rangiferina, C. arbuscula, C. gracilis* and *Cetraria islandica.* On sites where snow remains till late in the summer, Lapland cassiope (*Cassiope tetragona*) is the dominate subshrub.

The summer of 1969 was relatively normal: the plants flowered, produced seeds, and the deciduous species dropped their leaves by mid September. Then from October 6 to 25, a beautiful Indian Summer prevailed, with daily temperatures above normal (Table 1) under clear skies.

I was trapping microtines in a dwarf shrub-lichen stand on Anvil Mountain, three miles north of Nome, during October. On the 23rd, after a rain that lasted most of the morning, I noticed that Lapland cassiope was reflowering profusely.

Upon examination of other species, crowberry, which has small inconspicuous flowers, and the catkins of felt-leaf willow (*Salix alaxensis*) proved to be flowering as well. Although *Anemone multiceps, A. parviflora, Saxifraga oppositifolia* and *Geum glaciale* are normally the first plants to flower in the spring near Nome, I was unable to find any indication of flowering in these species. The buds on Alpine bearberry (*Arctostaphylos alpina*), another early flowerer, were enlarged. Crowberry and felt-leaf willow are among the early species to flower at Nome, but Lapland cassiope usually flowers after several other species. Weeden (1968) in Central Alaska found Lapland cassiope flowered about 15 days after the first species.

Crowberry and Lapland cassiope were among the few type 7 species, i.e. those that overwinter with fully developed flower buds and pollen, examined by Sørensen (1941) in Greenland. Of the other type 7 species listed by Sørensen (1941 Table 7) only Lapland rhododendron (*Rhododendron lapponicum*) was observed on Anvil Mountain and it was not found to be flowering.

Crowberry and Lapland cassiope are evergreens while most of the early blooming species are either deciduous or overwinter in basal rosettes. The common evergreens in the area that normally flower in the spring before Lapland cassiope include black oxytrope (*Oxytropia nigrescens*), Alpine azalea (*Loiseleuria procumbens*), eight petalled mountain avens (*Dryas octopetala*), diapensia (*Diapensia lapponica*), Lapland rhodo-

TABLE 1. — Temperatures and precipitation recorded at Nome during part of October 1969.

Date	Temperature max.	Temperature min.	Temperature ave.	Departure from normal	Precipitation
6	43	37	40	+ 6	.15
7	44	37	41	+ 7	.13
8	43	36	40	+ 5	t
9	37	30	34	+ 1	t
10	38	30	34	+ 1	t
11	39	29	34	+ 2	t
12	42	27	35	+ 3	t
13	49	40	45	+14	.13
14	47	40	44	+13	.10
15	50	36	43	+12	.03
16	49	35	42	+12	0
17	55	35	45	+15	0
18	48	35	42	+13	0
19	40	24	32	+ 3	0
20	37	29	33	+ 5	0
21	38	32	35	+ 7	0
22	39	35	37	+ 9	t
23	42	36	39	+12	.33
24	43	35	39	+12	.10
25	43	34	39	+13	.03
26	35	23	29	+ 3	0
27	30	17	24	− 1	0
28	26	11	19	− 6	0
29	22	6	14	−10	0

dendron and Labrador tea. I examined several of these species but found no indication of initiation of flowering. Felt-leaf willow, although deciduous, will develop catkins and leaves throughout the winter if cuttings are placed in moderate temperatures. It froze during the early morning hours of October 26 and by the afternoon all of the blossoms had wilted. To that time Alpine bearberry had not flowered.

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ROBERT E. PEGAU

Dept. of Fish and Game,
Nome, Alaska

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The Application of Closed-circuit Television to Nature Interpretation

Abstract. Closed-circuit television revealed two interesting sequences of predation. A short-tailed weasel was seen predating a ruffed grouse nest, and a garter snake was seen seven feet up a hawthorn tree at a goldfinch nest.

Modern technology is receiving its lumps from people concerned about the quality of our environment, and in many cases deservedly. However, there are some products of modern technology that are extending our knowledge and understanding of the environment. One such device used for display purposes at the Wye Marsh Wildlife Centre is the closed-circuit television system. Initially conceived to give the inexperienced city dweller some intimate views of nature, it has even on occasion startled the sophisticated naturalist.

Two recent views of predation of birds nests are worth noting. A ruffed grouse nest was the location of the first drama. The camera was set up on the nest with 11 eggs. A day after setting up the camera an egg was found unharmed 20 yards from the nest. By June 15 only six eggs remained. On the morning of June 15 the nest robber appeared — a short-tailed weasel.

As we watched, he took one egg at a time and carried it out of range of the camera. Each egg was taken in his mouth whole. During the weasel's trips back and forth to the nest, the mother bird spread her tail feathers and puffed herself up but remained very ineffectual. The weasel returned one final time, inspected the nest, and left to enjoy in private his bountiful repast.

The next encounter with a predator occurred again in the morning on August 1. This time the prey were six american goldfinch eggs, and the predator was a garter snake. The nest was located 7 feet up in a hawthorn tree. Unfortunately all anyone saw was the snake uncoiling from around the branch of the hawthorn tree above the nest preparing to leave the scene. Quickly, rushing out into the field, we discovered all the eggs were gone and the circumstantial evidence certainly pointed at the "aforesaid" garter snake.

There have been many interesting activities observed through the eye of our television camera, and we often wonder about some of the events we must miss.

WILLIAM D. BARKLEY

Environment Canada,
Canadian Wildlife Service,
Midland, Ontario.

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The Nessus Sphinx Feeding on Decaying Vertebrates in Ontario

Twice recently we have encountered a male of the Nessus Sphinx, *Amphion nessus* Cramer (Lepidoptera : Sphingidae), feeding in a manner that we suspect may be unusual in hawkmoths.

On 29 May 1970 at about 1400 hrs. E.D.T. a male was captured (by J.C.E.R.) feeding on the carcass of a decaying bullfrog on a bush road near the Queen's University Biological Station at Chaffeys Locks, Leeds County.

On 15 June 1971, there were large windrows of dead fish on the sandy beach at Sandbanks Provincial Park, Prince Edward County. Close to noon on that day, when it was cool and somewhat overcast, with a brisk southwesterly wind, a male

was captured (by P.S.C. and P.S.) probing with its extended proboscis a moist, dead, stranded fish. The moth was hovering and moving from one spot to another around the fish for about half a minute before it was caught. It probed particularly in places where the skin was broken and the flesh exposed.

A. nessus is known to fly in the daytime on cloudy days (Holland, 1937) and to be attracted by 'baits' and flowers (Hodges, 1971).

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Philip S. Corbet[1,4]
J. C. E. Riotte[2]
P. Spry[1,3]

[1]Research Institute, Canada Department of Agriculture, Belleville, Ontario.
[2]Department of Entomology and Invertebrate Zoology, Royal Ontario Museum, Toronto, Ontario.
[3]Student Assistant.
[4]Present Address: Department of Biology, University of Waterloo, Waterloo, Ontario.

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Grackles Retrieve Dead Smelt from Lake Erie

On 16 May, 1971 while looking for water birds on Lake Erie, several Common Grackles *(Quiscalus quiscula)* and Red-wings *(Agelaius phoeniceus)* were observed feeding on dead fish littering the beach at the tip of the Rondeau penninsula, Rondeau Provincial Park, Ontario. The dead fish, mainly American Smelt (*Osmerus mordax*), covered a zone about 2 feet wide for approximately 2.5 miles. On 19 May, about 3.5 miles north along the lake shore, I noticed a grackle flying toward shore carrying in its bill a long, slender fish that appeared to be a smelt. I soon saw several grackles flying low over the lake searching for dead fish floating on the water's surface.

I stopped seven times along a 4 mile stretch of the lake shore and at each place saw grackles foraging in the same manner. Typically, one or a group of two to four grackles would fly out low over the lake for a distance of 50 yards to 0.25 mile or more, gradually turning into the south wind and proceeding roughly parallel to the shore. Four captures were observed. Each time, a grackle suddenly circled and fluttered very close to the water over a fixed spot. The fish was plucked out of the water with the bill. Once a grackle made obvious contact with the water with its feet and breast. Following a capture, the grackles flew directly to shore, the fish dangling from their bills. They were often chased for a variable distance by one to three other grackles. Twelve different birds were seen returning to shore with fish in this manner; all fish appeared to be smelt about 6 inches in length. Apart from those pursuing a successful individual, only one grackle was seen returning to shore without a fish. No fresh smelt could be found recently washed upon the beach and grackles were not seen feeding on the hard, dried carcasses that were present.

Approximately 75 grackles were seen engaged in this activity in 30 minutes (17:30-17:45 hours and 19:10-19:25 hours). On 20 May, approximately 25 grackles were observed hunting in 15 minutes (18:10-18:25 hours) at three stops along the same stretch of shore. No captures or birds carrying fish were seen. Many grackles were seen on lawns and in trees along the lake shore both days. Probably several hundred grackles were involved in fishing.

Other bird species foraging for fish at the same time were Common Terns *(Sterna hirundo),* Black Terns *(Childonias niger),* Herring Gulls *(Larus argentatus),* Ring-billed Gulls *(L. delawarensis)* and Bonaparte's Gulls *(L. philadelphia).* No interaction between grackles and any of these species was noted.

On 19 May, winds were south at 10 to 15 mph., causing swells and waves of 3 to 6 inches while on the 20th, winds were less than 5 mph., and the lake was nearly calm.

The varied diet and opportunistic feeding behaviour of common grackles is well known; they commonly take eggs and nestlings of birds, and in addition to fish, occasionally prey on crayfish *(Cambarus spp.),* amphibians, birds, and even mice (several references in Bent 1958, pp. 406-409, Davis 1944, Hamilton 1951, Hodges 1951 and Taylor 1958). Most records of grackles taking fish involve captures from the edge of streams or ponds (Bent 1958) or from floating debris (Follet 1957). There are two observations of single birds catching small fish in the manner described in this note (Beeton and Wells 1957,

Cahalane 1944). Only Townsend's (1919) and Cottam's (1943) observations involved many grackles fishing on the wing. Townsend found grackles commonly capturing live Three-spined Sticklebacks (*Gasterosteus aculeatus*) at Boston, Massachusetts and Cottman described "dozens" of grackles plucking dead or injured small fish from turbulent water below a power plant in South Carolina.

It is not surprising to find grackles exploiting the seasonally abundant and readily available supply of dead fish along the shores of the Great Lakes. Smelt die-offs of varying intensity have occurred regularly since the early 1950's in Lake Erie during the latter half of April and first part of May (S. J. Nepszy *in litt.*) and may be an important source of food at a time when young grackles are being fed. The practice of hunting and retrieving dead smelt from Lake Erie when fresh dead fish are not available on the beach is probably widespread. Grackles were also commonly observed scavenging in picnic and camping areas and foraging around sloughs in the hardwood forest of Rondeau Park, within easy flying distance of the lake shore. Therefore, fishing for smelt may be restricted to a particular segment of the local population conditioned to feeding in this manner.

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J. P. PREVETT

Department of Zoology,
University of Western Ontario,
London 72, Ontario.

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Catbird at Churchill, Manitoba

While on a birdwatching and photographic trip to Churchill this spring, we had the good fortune to find a pair of nesting Pigeon Hawks, *Falco columbarius*, in a small boreal woodlot across from the research station (Northern Lights Observatory) east of Fort Churchill. It took several days to photograph these hawks and it was during this time, on June 18, 1971 that a Catbird, *Dumetella carolinensis*, was first heard and later seen.

It was about 10:00 A.M. and slightly overcast when we heard the distinctive cat-like mewing. Minutes later the bird appeared at the foot of a coniferous tree about 15 feet away from us. We could clearly see the blackish cap and rusty undertail coverts on this slate grey bird. It remained in the open for several minutes before moving out of sight. However, during that day we heard it calling frequently and saw it again on 4 or 5 occasions in the same area. For this reasons we felt it might be on territory or have a nest nearby.

As both of us are from southern Ontario where catbirds are a common breeding species, there could be no doubt in our minds as to the bird's identity.

We could find no record for a Catbird in Churchill in Jehl and Smith's book "Birds of the Churchill Region, Manitoba" or in other authorities such as Taverner and Sutton. We informed Mrs. Smith of our sighting and she may have since seen the bird.

Two long time residents of Churchill, Angus and Bernice McIver, mentioned seeing a Catbird near Churchill about 15 years ago. That bird was at Herriot Creek, which flows into the Churchill River about 20 miles south of the town of Churchill.

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R. BARRY RANFORD[1]
MRS. LINDA MCKEANE[2]

[1]1345 Kendall Rd.,
Mississauga, Ontario.
[2]85 Sherwood Ave.,
Toronto 12, Ontario.

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First Verified Record of the Black-necked Stilt in Alberta

On the afternoon of May 12, 1970, while observing shorebirds at a roadside alkali slough, known as Weed Lake, three-quarters of a mile north and one mile east of Langdon, Alberta (12 miles ESE of Calgary, Alberta), I located and photographed a Black-necked Stilt (*Himantopus mexicanus*). The single bird was feeding in very shallow water in the company of several American Avocets (*Recurvirostra americana*) and Wilson's Phalaropes (*Steganopus tricolor*). I observed the stilt over a period of half an hour and was able to photograph it. During the next two days, attempts were made by several ornithologists to relocate the bird, but these were unsuccessful.

Dr. W. Earl Godfrey of the National Museum of Natural Sciences, Ottawa, has kindly verified my identification of the stilt from the photograph that I took. Copies of these photographs have been filed with the National Museum and with Professor W. Ray Salt of the University of Alberta, Edmonton.

Previously the Black-necked Stilt has been on the hypothetical list for Alberta (Salt, W. R. & A. L. Wilk. 1966. *The Birds of Alberta,* Edmonton). This was on the basis of the finding of "recognizable parts of a dead stilt in the Brooks area apparently some time in the early 50's" (W. R. Salt, *in litt.*), but these were not retained, so the record could not be verified.

The northern limit of the breeding range of the Black-necked Stilt is "locally from S. Oregon, N. Utah, S. Colorado . . . casual, E. Wash., S. Idaho, Wyoming." (Peterson, R. T. 1961. *A Field Guide to Western Birds.* Boston.), and so it is only a very irregular visitor to Canada. Godfrey (1966, *The Birds of Canada.* Ottawa.) describes the Black-necked Stilt as accidental in Newfoundland and casual in New Brunswick, with a single sight record for Ontario. A claim of a nesting record from Saskatchewan (a set of four eggs reportedly collected at Qu'Appelle in 1894) was considered by Godfrey in 1968 (Auk 85: 562-563) as probably attributable to the American Avocet, the eggs of which are similar.

The 1970 record represents a wandering of at least 400 miles north from the normal range of the stilt. A Black-necked Stilt that visited Manitoba in 1969 (information received from Dr. Ray England), was almost twice that distance from the nearest breeding colonies.

A large low pressure system passed eastward across Montana and Wyoming just prior to May 12 and this brought snowfalls in southern Alberta on the two nights preceding the observation of the stilt near Calgary. It is possible, then, that this stilt was caught in that system while on migration, and carried by southerly and southeasterly winds northward into southern Alberta, thus overshooting its normal breeding range.

D. VAUGHN WESELOH

Department of Biology,
University of Calgary,
Calgary 44, Alberta.

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Clanculus microdon ater Pilsbry in British Columbia

Clanculus microdon ater Pilsbry, a widespread Indo-Pacific intertidal gastropod previously unknown in North America, can now be added to the growing list of exotic marine molluscs (see Bernard, 1970; Quayle, 1964) recently introduced in British Columbia. Routine identification of previously collected material has revealed ten live-collected specimens of this species from the mouth of Codville Lagoon (52°03. 5′N, 127° 52′W) about 12 miles north of Namu, British Columbia. The specimens, which are typical for the species, were collected by E. L. Bousfield on August 8, 1964 (station H56b, see Bousfield, 1968) at low water on barnacle-encrusted rocks and shells. Strong tidal currents, kelp, and a number of associated invertebrates (*Evasterias, Strongylocentrotus, Melita,* hermit crabs, etc.) were also noted by Dr. Bousfield.

In the Western Pacific *C. microdon ater* occurs from south of the equator to about 35°N on the east coast of Japan and to about 37°N on the west coast, i.e. to the central part of Honshu Island (Kuroda and Habe, 1952).

No Japanese oysters (*Crassostrea gigas* (Thurnberg)) have been introduced in or near Codville Lagoon and although *C. microdon ater* probably has pelagic eggs and larvae, it is almost inconceivable that its eggs and/or larvae could have been transported by ocean currents from an oyster

culturing area in the Strait of Georgia. No satisfactory explanation of its occurrence there can be given at this time. It appears probable that *C. microdon ater* will not become permanently established in its present isolated and northerly location.

Appreciation is expressed to Dr. E. L. Bousfield for providing specimens and notes, to Mrs. M. F. I. Smith for sorting and preliminary identification, and to Drs. Clyde Roper and Joseph Rosewater for access to collections at the Smithsonian Institution.

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A. H. CLARKE

National Museum of Natural Sciences
Ottawa

Eastern Kingbird on Southampton Island, N.W.T.

On June 23, 1971 at 9:00 A.M. the author discovered a lone Eastern Kingbird, *Tyrannus tyrannus,* perched on a clump of dwarf willow 1½ miles northwest of the settlement of Coral Harbour, Southampton Island, N.W.T. The bird remained on the same perch and was observed for about 10 minutes from a distance of about 25 feet. It seemed in the process of drying its plumage, for a cloud burst had recently passed. The bird was last observed flying due north.

Neither Sutton (1932), Bray (1945), nor Taverner (1934) report a kingbird in this area. However there is a record for this species from Coats Island 55 miles to the south (Godfrey, 1966).

A specimen found dead in July 1967, by Jonkel, 1970 on Leyson Point, 40 miles south and 65 miles east of Coral Harbour, was the previous northernmost record for eastern Canada. (Canadian Field-Naturalist)

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R. BARRY RANFORD

1345 Kendall Rd.,
Mississauga, Ontario.

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Second Record of Sparrow Hawk on Jenny Lind Island, N.W.T.

Of several unusual vagrants reported for Jenny Lind Island in Queen Maud Gulf by my party in 1966 (in "The Birds of Southeastern Victoria Island and Adjacent Small Islands," Natl. Mus. Canada Bull. 222, 1967: p. 70), none was more noteworthy than the Sparrow Hawk (*Falco sparverius*). In mid-May of that year (precise time not recorded) personnel of the DEW-Line Station observed a Sparrow Hawk entering one of the buildings during an unusual warm spell, though the land remained frozen throughout May and early June. The identification of the species was later confirmed by us when two adult males were found dead in snow near the station on June 1 and 23 respectively. The record was the first of its kind for the Canadian Arctic Archipelago.

On 27 April 1971 a female Sparrow Hawk showed up at the DEW-Line Station on Jenny Lind Island and was photographed by Walter Little and Charles MacKinnon who also were at the station during our stay there in 1966. Two photographs of the bird were sent to me, and there can be no doubt of the identification. Whether this bird survived is not known.

Taking into account that birds out of their normal environment likely would be attracted to sites such as a village, outpost, or station, it appears that more factors than simply chance are involved in the remarkable early northward flight of Sparrow Hawks to Jenny Lind Island.

DAVID F. PARMELEE

Field Biology Program,
302 James Ford Bell Museum of Natural History,
University of Minnesota,
Minneapolis, Minnesota 55455, U.S.A.

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Coastal Records of the Long-billed Curlew for British Columbia

Abstract. Coastal records of the Long-billed Curlew in British Columbia, from 1958 through 1970, are presented. The bird is presently a rare spring transient through the Vancouver area and only casual in fall here. On Vancouver Island the bird can be considered accidental in occurrence.

In British Columbia the Long-billed Curlew *(Numenius americanus)* is considered a summer resident in the southern interior of the Province (Munro and Cowan, 1947 and Godfrey, 1966). Although now scarce, due to increasing loss of undisturbed land, the Curlew still breeds here in grassy meadows between mountains. Recently, however, there have been many sightings and two specimen records for this species from the British Columbia coast.

From 1958 through 1970 Long-billed Curlews have been reported at least fifteen times in the southwestern corner of the Province, that is, near the populated centers of Vancouver and Victoria.

The first coastal record for this species was a sighting of three birds on the mud flats at Beach Grove (just south of Vancouver) by Dr. Lars von Hartman, Philip Symons and A. J. Erskine on October 26, 1958 (Erskine, 1960). Six years later R. E. Luscher observed a single bird on Sea Island on 16 May 1964. The Vancouver International Airport occupies most of this fairly large grassy island which is situated in the mouth of the Fraser River.

Two years later, in the fall, the late W. M. Hughes of Vancouver collected an adult female on Sea Island on 15 August 1966. The specimen was given to the Provincial Museum in Victoria by a friend of Hughes' (R. H. Halliday) where it is accessioned as catalogue number 11635. The following spring, a single bird was observed again on Sea Island by R. E. Luscher on 18 May 1967. The same day, presumably the same bird, was seen on Iona Island, just to the north of Sea Island, by myself.

There are two spring sightings for 1968. Single birds were seen on the mud flats at Iona Island on 20 May (R. G. Foottit, T. Stevens and myself) and 25 May (R. E. Luscher).

There are no records in 1969 for mainland British Columbia, however, G. A. Poynter observed a bird in Victoria, at the southern tip of Vancouver Island, on 11 August 1969. This sighting constitutes the first record for this species on Vancouver Island.

There are several spring records for 1970. On 27 April R. E. Luscher sighted an adult Long-billed Curlew on Iona Island. The sighting was confirmed by R. Phillips on 3 May and on 6 May two adults were seen on Sea Island by myself. The following day a bird was shot as part of the bird control program at the Vancouver International airport. The specimen, an adult female, was given to the University of B.C. in Vancouver where it is now specimen number 13463 in the Vertebrate Museum there. Stomach contents revealed, in part or whole, 31 earthworms and 17 beetles.

On 10 May 1970 Werner and Hilde Hesse watched an adult Curlew at Canoe Pass, just south of Sea Island and on 17 May another single bird was observed feeding among the short grass fields on Sea Island by W. J. Anderson and myself.

The Long-billed Curlew can presently be considered a rare spring transient through Vancouver. The earliest spring arrival is 27 April 1970, the latest departure is 25 May 1968. It is casual in fall here.

The bird would have to be listed as accidental on Vancouver Island.

I would like to express my gratitude to members of the Vancouver Natural History Society for permission to use their records in this note.

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R. WAYNE CAMPBELL

Vertebrate Museum,
Department of Zoology,
University of British Columbia,
Vancouver 8, B.C.

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Greater Scaup is Common Breeder on Northern Lake Winnipeg

A dozen Greater Scaup *(Aythya marila)* were observed by the senior author on a pond on Little George Island, 52°52′N, 97°47′W in Lake Winnipeg, Manitoba, during a visit by float plane on June 24, 1970 to the Caspian and Common Tern colonies there. The scaup were suspected to breed there, but there was then no time to search for nests. In 1971, the island was occupied by the two junior authors and visited by the senior author in June and July and 13 nests, plus one brood, of Greater Scaup were found. The scaup nested in tall grass and underneath shrubs between the pond and the tern colonies. Besides the Greater Scaup one nest each of a Pintail, American Widgeon, Common Goldeneye, Common and Red-breasted Merganser also were located. The Common Goldeneye nested in an open tree hollow, while the mergansers nested underneath an old cabin and underneath a shrub.

The Greater Scaup were identified independently by sight observations by the first two authors. The Greater Scaup may be confused with the Lesser Scaup, *Aythya affinis*. The senior author is very familiar with the latter species from studies in Alberta (Vermeer, 1968, 1970). The second author observed Lesser Scaup offshore Little George Island on four out of ten days in the first half of July with most birds being seen in a group of 17 on July 8.

This is a breeding record of Greater Scaup on Lake Winnipeg, which is about 300 miles south of the breeding boundary for this species as indicated by Godfrey (1966). However, the A.O.U. Checklist (1957:84) indicates that Greater Scaup breed in "North Dakota (rarely Lower Souris Wildlife Refuge, probably Devils Lake), and southeastern Michigan (St. Clair Flats, one record)."

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[In this connection, there is an old assertion by E. B. Dunlop (1915, *Aux* 32(4): 500) that the Greater Scaup was then ". . . undoubtedly the most plentiful breeding duck mid-way up the west side of Lake Winnipeg". This statement has been ignored heretofore by most ornithologists apparently pending proof that Dunlop had not confused this species with the similar Lesser Scaup, *Aythya affinis*. It is now plain that Dunlop was right. — W. E. G.]

K. VERMEER
D. R. M. HATCH
J. A. WINDSOR

Canadian Wildlife, Edmonton

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New Records of Sculpins (Cottidae) from the Coasts of British Columbia and Washington

Abstract. The known geographic ranges of the sculpins *Artedius meanyi* and *Radulinus boleoides* are extended to northern British Columbian waters while that of *Nautichthys robustus* is extended from British Columbia into the state of Washington.

Many species of marine fishes are now known to be more widely distributed on the Canadian west coast than previous literature records have indicated (Hart, in press). The following records of species from the coastal waters of British Columbia and Washington are indicative of this trend.

Artedius meanyi (Jordan and Starks), Puget Sound sculpin:

Rosenblatt and Wilkie (1963) recorded the known range of the Puget Sound sculpin (*Artedius meanyi*) from Puget Sound, the Strait of

Juan de Fuca, and Howe Sound. Since then, McAllister (in Hart, in press) recorded the species from lat. 51° 09′ N. and long. 127° 55.5′ W., on the basis of a specimen (27.9 mm SL) deposited at the National Museums of Canada (cat. no. NMC68-373). Recently another specimen (NMC 67-346) caught at a depth of 45 fathoms (82 m) on August 9, 1967, from lat. 53° 52′ N. and long. 133° 19′ W. came to my attention. This specimen (20.4 mm SL) from off the Queen Charlotte Islands suggests the species may be found occasionally throughout the length of the British Columbia coast. The 82 m depth of capture also extends the 1.5 to 7.6 m depth range recorded by Rosenblatt and Wilkie (1963).

Although damaged, the specimen recorded here is readily identifiable from other members of the genus because of the distinctive scales distributed over the entire surface between the lateral line and dorsal fins and onto the caudal peduncle below the caudal raylets.

Nautichthys robustus Peden, shortmasted sculpin:
Previously, only eight specimens of the shortmasted sculpin (*Nautichthys robustus*) were recorded between Attu Island, Alaska, and the Queen Charlotte Islands, B.C. (Peden, 1970). Since then a misidentified collection containing nine more specimens was found at the United States National Museum. According to its museum label, the specimens were captured in the state of Washington at Albatross Stn. 2865 (lat. 48° 12′ 00″ N. and long. 122° 49′ 00″ W.) at a depth of 40 fathoms (73 m) on September 6, 1888. Townsend (1901) recorded the temperature at the depth of capture to be 51.7° F. (10.9° C.) and the bottom to be composed of pebbles. The nine specimens reported here more than double the total number of known specimens of *N. robustus* and extend the known range more than 550 miles southward into northern Washington.

The counts of these nine specimens (cat. no. USNM 127026) are as follows:

Specimen no.	Standard length (mm)	dorsal rays	anal rays	pectoral rays	lateral line pores
1	26.8	IX-21	15	15	38 + 1
2	30.1	VIII-21	16	15	38 + 1
3	28.9	VII-20	15	15	36 + 1
4	28.6	VIII-20	15	15	37 + 1
5	25.4	VIII-21	14	15	38 + 1
6	27.0	IX-20	15	15	38 + 1
7	30.1	VIII-20	14	15	38 + 1
8	27.9	VIII-21	15	15	38 + 1
9	24.6	VIII-20	14?	15	37 + 1

Because all these specimens have fewer than 22 soft dorsal fin rays and possess pointed head spines, these characters are consistent with those Peden (1970) described as diagnostic for *N. robustus*.

Radulinus boleoides Gilbert, darter sculpin:
Although the rare darter sculpin (*Radulinus boleoides*) was known for many years from California and Washington (Bolin, 1944), only recently has a specimen been found in the marine waters off British Columbia (McPhail, 1970). On June 5, 1969, the late Dr. Clifford Carl captured a specimen of this species from a depth of 40 fathoms (73 m) near Langara Island (approximately 54° 12′ N. latitude and 133° 00′ W. longitude) while he was aboard the Fisheries Research Board of Canada's vessel *G. B. Reed.* This record extends the known range of the darter sculpin 300 miles further north and indicates the species must be considered a possible resident of suitable habitats along the entire coast of British Columbia.

The counts of this British Columbia specimen are: right pectoral rays, 18; left pectoral rays, 19; dorsal rays, X, 20; anal rays, 21; lateral line pores, 40. Because the right pectoral count falls only within the range recorded by Bolin (1944) for *Radulinus asprellus* and the other counts overlapped the ranges given for both *R. boleoides* and *R. asprellus,* identification proved difficult. In addition, the diagnostic measurements (i.e., snout length = 1.2 times orbit diameter and pelvic fin length = 1.2 times the pectoral fin base) were barely within the ranges listed by Bolin for *R. boleoides;* however, greater variation should be expected because Bolin only examined three specimens. Because the northernmost specimen recorded here possessed short rather than long nasal spines, more scales on the anterior region of the head, and a cirrus on the posterior part of each eyeball, the identification of the specimen agrees with Bolin's description of *R. boleoides* and not with that of *R. asprellus.* The specimen is now deposited in the collection of the British Columbia Provincial Museum. (cat. no. BCPM 69-9).

Acknowledgements

Dr. Josephine F. L. Hart provided some of the data on *Radulinus.* Dr. John L. Hart permitted use of his MS in press on B.C. fishes.

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ALEX E. PEDEN

British Columbia Provincial Museum
Victoria, B.C.

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An Observation of Killer Whale Predation on a Dall Porpoise

Abstract. The behavior of two killer whales *(Orcinus orca)* was observed near a Dall porpoise *(Phocoenoides dalli)* grounded in shallow water. The whales waited at least 20 minutes until the porpoise was accessible in deeper water and then immediately captured it and swam farther offshore. After "playing" with the porpoise for several minutes, the whales disappeared with it.

On October 30, 1971, we observed two killer whales *(Orcinus orca)* preying upon a Dall porpoise *(Phocoenoides dalli)* near Auke Bay, Alaska. The observations were made between 9:00 and 9:30 a.m. on a beach on the east side of lower Lynn Canal, about 16 miles north of Juneau, Alaska. The weather was cloudy with occasional light rain showers. There was a very light wind and the resultant onshore waves were less than 1 foot high. The tide was flooding and was about halfway between low and high slack. The water appeared clear. The beach where the incident occurred is rock rubble and has a slope of approximately 10 degrees. Beyond the zero tide level, the beach changes to sand and has a grade of approximately 5 degrees.

When we first saw the two killer whales, they were cruising parallel to shore about 30 to 40 feet off the beach in water probably no more than 6 to 10 feet deep. The dorsal fins and upper backs of the whales protruded above the water. The whales were probably a young male and a female; one had a moderately high, straight dorsal fin and the other had a slightly lower, curved dorsal fin. Immediately after we first saw the whales, we noticed a Dall porpoise moving feebly at the edge of the water directly inshore of the two whales.

The porpoise, about 5 feet long, was grounded and awash in about 10 inches of water. It was resting on its side against the bottom and was partly exposed above water; its primary motion was caused by the waves. Periodically the porpoise would right itself, breathe, then fall back to its previous position. It was bleeding slightly along the anterior edge of the pectoral limbs and flukes; the bleeding was probably from cuts sustained as the animal rubbed against the barnacle-covered intertidal rocks. The body of the porpoise was covered with scratches, but aside from these and the slight bleeding, no external injury was evident. We approached until we could touch the porpoise; the only visible reaction to our contact was a slight thrashing.

As we stood near the porpoise, the two killer whales swam slowly back and forth, at times parallel to the beach and at times shoreward and seaward. The movements of the whales during approximately 20 minutes, timed from our arrival at the scene were executed within an area extending about 50 to 70 feet north and south of the porpoise laterally along the beach and between 30 and 200 feet offshore. Their movements seemed slow and deliberate as they rolled, swam at the surface, or disappeared briefly from view. Two or three times the whales remained out of sight under water for 3- to 5-minute intervals. Several times they lay still at the surface, facing the beach, for as long as half a minute. Once one of the whales raised the front of its head out of the water while it was facing shoreward.

At the end of the 20-minute interval, the whales made a particularly close pass, about 30 feet from the edge of the water. Both whales had their backs well out of water as they moved from north to south parallel to the beach. By the time the whales made this close pass, the porpoise had moved free of the rocky bottom and had drifted parallel to the shore about 15 feet south of its

original position. When the whales were close, the porpoise thrashed each time they breathed. As the whales passed south of the porpoise, it abruptly righted itself, turned seaward, and swimming at the water's surface, slowly moved into deeper water.

When the porpoise was about 25 feet offshore, the two killer whales turned northward along a course that intercepted that of the porpoise. Just before the whales reached it, the porpoise submerged. The whales also momentarily submerged, and the next time we saw the animals the whales were swimming at the surface and the porpoise was in the mouth of the female.

After capturing the porpoise, the killer whales abruptly turned toward deeper water, surfacing occasionally. When the whales were several hundred yards offshore, they paused to "play" with the porpoise. Once one whale jumped out of the water with the tail of the porpoise clearly visible protruding from its mouth. Shortly thereafter, the porpoise was seen feebly swimming at the surface, its head held partly out of water. One of the whales, swimming in the same direction as the porpoise, surfaced and then submerged about 30 feet behind the porpoise. Within seconds, the whale came up beneath the porpoise, leaping partially clear of the water as the porpoise slid off its side. After less than 5 minutes of "playing" the whales, apparently with the porpoise, disappeared beneath the surface of the water and were not seen again. Soon after they disappeared, a flock of gulls gathered and appeared to be feeding where the whales had last been seen.

Although we did not witness the beginning of this encounter between the whales and the porpoise, there is reason to believe it began some distance from the beach where we first saw the animals. Killer whales are commonly seen in the lower Lynn Canal area and may be offshore in the deep water or near shore in very shallow water. Dall porpoises are also common in the area, but they are normally seen only in the deeper waters. Occurrence of the Dall porpoise in very shallow water indicates that it was either a sick or abnormal animal or had been driven or carried to the shallows by the killer whales. Perhaps the whales had captured the porpoise in deep water and during a period of "play" similar to that which we observed, had carried the animal to the shallow area where it temporarily escaped into water too shallow for the whales to follow.

Two points in this observation seem significant. First is the killer whales' tenacity in "waiting" for prey that was at least temporarily beyond their reach. Second is the whales' apparent ability to locate their prey across extremely shallow water. Although the water between the whales and the porpoise was relatively clear, it seems unlikely that the whales could have seen the porpoise from 30 feet away — the minimum distance. Perhaps contact was maintained by sounds emitted by the porpoise or by echolocation by the whales; or perhaps, more simply, the whales just remained in the area where they lost contact with the porpoise.

NANCY BARR
LOUIS BARR

National Marines Fisheries Service
Auke Bay Fisheries Laboratory
Auke Bay, Alaska 99821

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A New Northern Distribution Record of *Pomoxis nigromaculatus* (Lesueur)

Abstract. The known range of the black crappie, *Pomoxis nigromaculatus*, is described in general terms. In 1966, two black crappie were caught in Sipiwesk Lake, Manitoba. This is about 300 miles north of the former known northern limit for the species.

The black crappie's native range is east of the Rocky Mountains, from southern Canada to the Gulf States (La Gorce, 1952). More specifically, its range has been described as including the Great Lakes, the upper Mississippi Valley to western New York (Blair, 1957) and southward to Florida, Louisiana, and Texas (Jordon, Evermann, and Clark, 1930). The western range in this area extends from eastern Nebraska south to eastern Texas (Blair, 1957).

In Ontario the black crappie is found in the Rideau drainage system, Lake St. Clair, and in the Lake of the Woods area (MacKay, 1963).

The black crappie has been introduced in Saskatchewan but does not seem to have established itself there as of 1949 (Rawson, 1949). The species has also been introduced in Oregon, Washington and occurs also in the lower Fraser Valley of British Columbia (Carl, Clemens, and Lindsey, 1959). Likewise, through introduction, the

black crappie is now widely distributed in North Dakota (Dotson, 1964).

The northern limits of the black crappie have previously been established as the Red, Assiniboine (Hinks, 1943), and Winnipeg rivers, the southern portion of Lake Winnipeg, and Minnewasta Lake in Manitoba (Keleher and Kooyman, 1957). The fish was accidentally introduced to Minnewasta Lake. Throughout its range in Manitoba, the black crappie is uncommon.

From the above information it would appear that the most northern established limit is the southern portion of Lake Winnipeg, (approximately 50° 50′ N. x 96° 30′ W.).

The writer received a black crappie, July 27, 1966. This fish was caught in Sipiwesk Lake, (55° 05′ N. x 97° 24′ W.) Manitoba. The fish weighed 0.7 pounds and measured 10 inches long (fork length). Another specimen caught August 16, 1966 by an angler measured 11 inches long (fork length) and weighed 0.85 pounds dressed. This black crappie was caught in Bulger Lake which is actually a bay of Sipiwesk Lake.

Sipiwesk Lake is approximately 320 air miles north of the southern shore of Lake Winnipeg. Since the former northern distribution record for the species was the southern part of Lake Winnipeg, it appears that these specimens caught in Sipiwesk and Bulger Lakes have extended the known northern limit of the species by approximately 300 miles in Manitoba. It is possible for the fish to move from southern Lake Winnipeg to the northern end of the lake, and then travel down the Nelson River, through Cross Lake and eventually into Sipiwesk Lake. It will be interesting to see if in the next few years black crappie are found in the northern portion of Lake Winnipeg, or at other locations on the Nelson River system.

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R. O. SCHLICK

Department of Mines, Resources and Environmental Management,
The Pas, Manitoba.

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Two New Records for Pinedrops (*Pterospora andromedea* Nutt.) for Ontario and Quebec[1]

According to current manuals (Fernald, 1950; Gleason, 1952), pinedrops, *Pterospora andromedea* Nutt. (Pyrolaceae) is relatively rare in the eastern part of North America but is fairly common in the western part. I believe that this unusual saprophytic plant can best be described in the words of Fletcher (1889), "It is a curious plant, consisting of a stout pinkish-white, erect, clammy-pubescent fleshy stem about two feet in height, bearing at the base lanceolate scales instead of leaves, and above nodding white flowers like those of Andromeda, in a long bracted raceme. Root, a mass of fleshy fibres. It is supposed to be a parasite on the roots of pines."

Because of the paucity of specimens in herbaria, I feel it is desirable to place on record two very fine pinedrops specimens, one sent for identification by Mr. George H. Hammond of R.R.1, Havelock, Ontario, the other collected by H. A. Thomson at Paugan Falls, Quebec. Mr. Hammond's accompanying label gives, "Marmora, Ontario, under dry pines (dry site), *G. H. Ham-*

[1]Plant Research Institute Contribution No. 863.

FIGURE 1. The distribution of *Pterospora andromedea* L. in southern Ontario and western Quebec.

mond, 20.VII.71." I did not find this species during my Marmora survey made in 1952 (Gillett, 1952) nor as far as I am aware has anyone found it subsequent to that time. Mr. Thomson's label gives, "Paugan Falls, Low, Quebec, Ottawa Field Naturalists' Club Outing, July 3, 1971."

Other Ontario and Quebec records are as follows:

W. G. Dore 9019, July 1948, pine wood on ancient shore dune, Wasaga Beach, Simcoe County, Ontario. (DAO).
John Dearness 1420, Middlesex County, Lobo Township, Komoka, Aug. 22, 1888 (DAO).
John Dearness, Lambton County, Sarnia Township, Sarnia, Ontario, Aug. 1, 1888 (DAO).
R. P. Burcher & L. O. Gaiser 2915, July 17, 1940, from Grand Bend, Lake Huron, about 2 miles south of settlement on highway 21 in oak woods under Hamamelis. (DAO).
J. Macoun, Belleville, Ontario, undated (DAO); probably the same collection dated July 27, 1861 (CAN).
Mrs. *R. G. Gibson,* Calabogie, Ontario, Aug. 10, 1952 (DAO).
Dr. *George Young,* Oxbow Park along the Nottawasaga River, 12 miles from Collingwood, in red pine woods (CAN).
J. Macoun, Quebec, Gatineau County, Ironsides, Gatineau River, July 31, 1903 (CAN).
Mrs. *Percival,* Quebec, Spencer Wood, near the Plains of Abraham, 1820. This specimen, by the way, has the distinction of being perhaps the "earliest Canadian specimen preserved in DAO", according to a note by W. G. Dore which is affixed to one corner of the voucher.

J. H. Soper and M. K. Warren recorded but did not collect specimens of pinedrops from Manitoulin Island at Kagawong, along the river between Mudge Bay and the Falls on July 24, 1963, and J. H. Soper and J. E. Purchase also recorded it from the Lake Superior shore between Alona Bay and Pte. aux Mines, Township 29, Range 14, Lots 11-12. Again no specimens were made.

Pterospora andromedea was recorded for Hamilton, Ontario, by Logie (1861) and by Buchan (1874). Fletcher (1879-80) included the

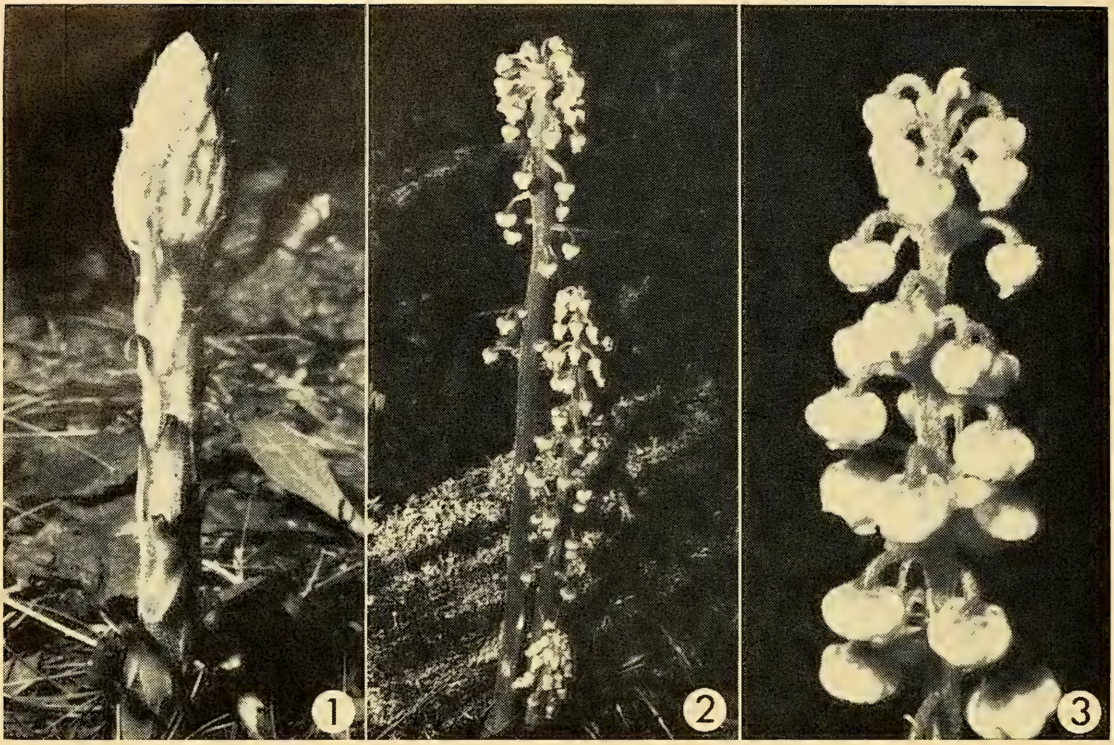

FIGURE 2. Young flowering shoot (1); mature plant (2); close-up of inflorescence (3). Photographs courtesy H. A. Thomson, Ottawa.

species in his Flora Ottawaensis. Macoun (1884) recorded it from Ottawa, Belleville, Canniffton (in Hastings County), Meyersburg (in Northumberland County), from along the Humber River west of Toronto, from Gline's mill west of Hamilton, and from Niagara Falls, Ontario. Fletcher, Small and Baptie (1888) recorded that Mr. A. J. Forward had found it at Rockcliffe, Ontario, near Ottawa. Fletcher (1889) repeated this a second time in reporting that it occurred along the Gatineau River, Quebec, between Ironsides and Chelsea. In 1894, Armstrong reported pinedrops from Scarboro Heights, in a small ravine east of Victoria Park. Boughner (1898) indicated that it was, "so frequent on Long Point Island, Lake Erie as to be almost termed common." Dickson and Alexander (1900) mentioned that the species was included in the Logie collection but according to Dickson (1904-5) it had been previously reported by Judge Logie himself in 1860 from Hamilton. Finally we have a report from Sturgeon Point, Victoria County, Ontario, in a letter from Miller Stewart (or Stewart Miller, it isn't clear!) dated August 28, 1952.

These literature reports, which were kindly furnished from the University of Toronto file by Dr. J. H. Soper, and the herbarium specimens cited, have been plotted on the accompanying map. Literature records appear as open circles; herbarium records as solid dots. The photograph of the plant is provided through the courtesy of Mr. H. A. Thomson.

Pinedrops is probably rare because it occurs only under certain conditions. One has to be "johnny-on-the-spot" so that it is more likely to be picked up by residents interested in the local flora than by collectors who are able to make only periodic visits to a region.

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JOHN M. GILLETT

Plant Research Institute,
Ottawa, Ontario.

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GATINEAU PARK — A PROPOSAL FOR ITS CONSERVATION AND USE

The National and Provincial Parks Association, Ottawa/Hull Chapter, has published a master plan for the conservation and use of Gatineau Park, an 88,000 acre piece of semi-wilderness in Quebec at the doorstep of the National Capital. The plan, published in both English and in French editions contains 54 pages (plus a large map) and is produced in a professional format.

This plan received exceptionally favourable comment and coverage in local newspapers. It will serve as an excellent model for citizens' groups in other parts of Canada for it shows how a small dedicated group of people can take constructive initiatives for parks on behalf of their community.

Available for $2.00 (French or English) from the Ottawa/Hull Chapter, National and Provincial Parks Association of Canada, Box 6242, Postal Station J, Ottawa 13, Canada.

IN MEMORIAM: JAMES WALTON GROVES, 1906-1970

SHEILA C. THOMSON[1]

James Walton Groves was born at Kinburn, Ontario, and spent his early childhood on the family farm in Fitzroy Township. A child of unusual ability, at the age of four he amazed family and friends by teaching himself to read, mastering the alphabet from a decorated baby bowl. He attended school in Ottawa, graduated from Ottawa Normal School, and taught in Ottawa before studying at Queen's University. In 1930 he obtained his B.A. in Biology and Chemistry from Queen's University. His post-graduate work in Mycology and Plant Pathology was done at the University of Toronto where he obtained a Masters Degree in 1932 and Ph.D. in 1935.

While studying at Toronto, he did summer field work at the biological station at Timagami. It was here that he met, and subsequently married, Elsie Reah, a happy marriage that lasted until Elsie's death some twenty years later. Shortly after their marriage, in 1936, the Groves moved to Ottawa, where Walton Groves took up a position as mycologist with the Department of Agriculture.

It was at this time that he joined The Ottawa Field-Naturalists' Club, and for more than thirty years was an active member, contributing in many ways to the activities of the organization. He was a member of Council from 1941 to 1967, and served variously as Secretary (1942-45), Vice-President (1948-50), and President (1951-1952). He was convinced that the most important work of The Ottawa Field-Naturalists' Club was the publication of The Canadian Field-Naturalist, and for seven years he served as Chairman of the Editorial Committee (1955-62).

A keen naturalist, he pursued his hobby of bird-watching enthusiastically. In Ottawa, his place of work was located in the Arboretum of the Central Experimental Farm where he habitually took a bird-watching stroll after lunch, and carefully recorded his bird observations each day. These records were kept for a number of years, and should be of considerable interest to students of changing bird populations. He had an intense interest, too, in wild mushrooms, and many Canadians will remember him as the author of Edible and Poisonous Mushrooms of Canada. Field trips under his leadership were always rewarding, as he took pleasure in sharing his knowledge with others, and was an excellent teacher.

In the Department of Agriculture he rose to the position of Chief of the Mycology Section of the Botany Division (later Plant Research Institute), a position which he held until 1967 when he returned to full-time research. In his chosen field of mycology, he was an authority on several groups of fungi, notably the Sclerotiniaceae and Dermataceae. Appended is a complete list of his scientific publications.

In 1957, Walton Groves married Dr. Naomi Jackson, daughter of artist H. A. C. Jackson, whose interest in fungi and talent as an illustrator of wild mushrooms had led to family friendships. Again a happy partnership was formed, which lasted until his death in May of 1970. He took particular pleasure in the artistic accomplishments of his wife, who was a favourite niece and pupil of artist A. Y. Jackson.

Dr. Groves was a member of many professional organizations, and held influential positions in a number of them. He was a member of the American Institute of Biological Sciences, the British Mycological Society, the Danish Mycological Society, and the International Association of Plant Taxonomists. He was a charter

[1]Mrs. Thomson is the president of the Ottawa Field-Naturalists' Club.

JAMES WALTON GROVES, 1906 - 1970

member of the Canadian Phytopathological Society and the Canadian Botanical Association. He served a term as Vice-President of the Mycological Society of America, and was a member of the Special Committee on Fungi (Nomenclature Section) in the International Botanical Congress. In 1951 he was made a member of the Royal Society of Canada, and subsequently served on various committees in that Society.

In spite of the esteem accorded him by his colleagues the world over, his staff knew him as a quiet, unassuming man, friendly, approachable, and always kind. Especially refreshing was his youthful capacity for enjoyment of whatever pursuit was at hand. With his death, the Ottawa Field-Naturalists' Club has lost an outstanding Canadian, a distinguished scientist, and a very fine naturalist.

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James Walton Groves

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A Canadian Ornithological Records Committee

This letter addresses itself to the question of what procedure could or should be adopted before a record of a new bird species for Canada can gain official admittance to the Canadian List, and how this List could be maintained.

It has long been recognized (although apparently only recently in Canada) that to accept records only of birds that have been shot for collections is simultaneously a morally unacceptable and a scientifically invalid procedure. At the same time it has to be admitted that the existence of a properly-labelled and fully-documented specimen provides rather strong (if not infallible evidence) that an individual of a species did occur at a certain place at a certain time. If any attempt is to be made to widen the basis upon which ornithological records may be regarded as officially acceptable, the methods by which observations are recorded must measure up to the highest standards demanded by science.

In southern Vancouver Island the problem of local rarities is dealt with by a local Records Committee whose function it is to examine the evidence upon which reports are based, and to publish, in an Annual Bird Report for Southern Vancouver Island, those records for which the evidence is considered to be unassailable, together with the evidence upon which the records were accepted. So far the scheme is operating extremely successfully, and the various problems that have arisen are being solved by experience. It was the problem of how to handle records of species new to Canada which prompted the publication of this letter. So far this year two such problems have been reported in our area. To satisfy the curiosity of the reader, these are the Allen's Hummingbird, *Selasphorus sasin,* and the Hermit Warbler, *Dendrocia occidentalis.* These records have not yet been considered by the local Committee so that I can say no more about them at this stage except to warn that at present neither should be regarded as official additions to the Canadian List. The point is, however, that, even if the local Committee is satisfied, it is doubtful, to say the least, if all ornithologists in Canada would feel bound to accept its findings.

What is proposed in this letter is the formation of a Canadian Ornithological Records Committee whose function would be to scrutinize the evidence (whether sight, photographic or specimen) upon which records new to or extremely rare in Canada are based, and to be responsible for maintaining an official Canadian Checklist.

The Committee might number about ten members widely distributed across Canada. Members would be ornithologists who not only have an extensive experience with North American birds, but are capable of examining evidence submitted to them carefully, objectively and in detail, and who are prepared to handle both the ornithology and the paperwork in a businesslike manner. The Committee would not be entirely composed either of professionals or of amateurs. The only requirement in forming the Committee is that the members selected are those who are best suited to carry out this task with energy and responsibility.

There are several methods by which such a Committee could work, and I do not propose to suggest details here. What I do suggest is that such a Committee be nominated and hold an early meeting at some central city such as Winnipeg during the coming year to discuss carefully the problems and to formulate the terms of reference of the Committee and the rules by which it will work.

I would very much hope that a record can be definitively regarded as an official addition to the Canadian List on the day when the record is published in *The Canadian Field-Naturalist* together with the words "this record has been accepted by the Canadian Ornithological Records Committee".

I would be very glad to have readers' comments on this proposal and, in particular, to hear from ornithologists, amateur or professional, who might be willing to serve on such a Committee or can suggest the names of likely members.

J. B. Tatum

Chairman,
Ornithological Records Committee for
Southern Vancouver Island,
416-3187 Shelbourne Street,
Victoria,
British Columbia

Reviews

Living and Fossil Brachiopods

By M. J. S. Rudwick. Hutchinson University Library, London. 1970; Humanities Press, New York, 1971. 200 p. illus. Cloth $6, Paper $2.50. Biological Series.

The phylum Brachiopoda occupies a minor niche in today's oceans, represented by about 300 species, many at considerable depth or hidden in caverns of coral reefs. But in Paleozoic times brachiopods were the predominant macro-invertebrate marine phylum and are of considerable economic and cultural significance for correlation and evolution. Martin Rudwick's book is concerned primarily with what is at first sight of lesser interest, the functional morphology of living and fossil brachiopods. This field of study is however relevant to correlation and evolution, if we accept Smut's wholistic philosophy and regard our scientific subdivisions as artificial. The book is eminently readable and copiously illustrated. Emphasis is placed on attachment, feeding, protection, reproduction — in short the day to day routine of brachiopods, partly interpreted from living material, partly from fossil material and model studies by means of word-based logic. The strength of the book lies in the fact that the author has woven the functional morphology of the enormously diverse and long lived brachiopod phylum into one seamless garment, smoothly changing focus from Recent to Ordovician to Devonian examples. It is so well presented that the book has all the "charm" of a nineteenth century nature study. As in many rustic studies little use is made of mechanics and hydrodynamics, or mathematical appraisal and economy, or computer based models.

Even within these limits, the morphology is curiously flaccid and generalized, with several structures, and most variants, unmentioned. For this reason the overall effect is stimulating because the well advised reader will see enormous possibilities of further research in exploring variation, and the vital field of ontogenetic change, and its functional significance, already examined by Russian and other workers, but barely mentioned in the text.

Rudwick concludes his text with strictures on other paleontologists and neontologists. To him "there is a lack of critically evaluated functional interpretation of fossil brachiopods". If we are to agree with Rudwick, and of course exclude his own work from criticism, we must nonetheless have misgivings over the lack of attention in the text to a great deal of published work which seems to go partway towards filling this need. Furthermore, the reviewer finds it impossible to hope with Rudwick that "paleontologists outgrow their subservience to stratigraphy". If more attention had been paid in the text to the stratigraphically controlled succession of morphological adaptions known for brachiopods, and more attention to dramatic changes in climate, ecology, continental drift, and orogenies, it would have been possible to impart dimensions of time and change in his text. His canvas was too small, the colours too few. So the final chapter on evolution merely summarises observations of morphology, dry as dust, with no explanation, or real insight to underlying causes.

The fascinating field of functional morphology will gain relevance and stature by being woven into earth history as a whole in terms of change, ontogeny, and evolution as a continuing response to changing environments. Sitting at sea-side pools, and thinking about how ill-named, ill-described shells open and shut will help this, but we also need more paleontology, not less, in the form of good systematic work, on controlled stratigraphic successions.

J. B. Waterhouse

Department of Geology,
University of Toronto,
Toronto, Ontario.

Pollen and Spores of Chile

Modern Types of Pteridophyta, Gymnospermae, and Angiospermae. C. J. Heusser. University of Arizona Press, Tucson, Ariz. 1971. 167 p. $15.00.

One of the most serious impediments to the development of palynological studies of the history of floras and environments is the lack of reliable aids to the identification of microfossils. Investigations of the Quaternary history of tropical and subtropical countries have been particularly hampered in this way.

Professor C. J. Heusser has made a notable contribution to the palynology of the Americas

by the completion of his survey of Chilean pollen and spore types. He offers clear descriptions, a straight forward key and photomicrographs of good quality, in presenting the diagnostic information on all the significant pollen/spore types of the country.

This book will be essential for palynologists working in the tropical and subtropical Americas, of great interest to all palynologists and pertinent to students of Angiosperm taxonomy.

Dr. Heusser is to be congratulated on this notable contribution.

J. C. RITCHIE

Chairman, Life Sciences Division
Scarborough College
University of Toronto
West Hill, Ont.

Analysis of Temperate Forest Ecosystems

David E. Reichle (ed.). Springer-Verlag, New York. 1970. 304 p. $14.50. Ecological Studies Series vol. 1.

Ecology's time has come, inevitably, universally and perhaps permanently. Unlike other disciplines of science, ecology's advent at the forefront of interest and importance was brought on largely by public awareness and general concern among scientists. There were no sparkling breakthroughs or discoveries by ecologists to propel the subject into prominence.

Contemporary writings reflect this uneasy status. In North America we are being deluged by books and pamphlets on the ecological crisis, many of them republishing the same articles with dreary regularity. Most take an excessively gloomy, emotional view of the future of the earth and few succeed in retaining the cool, analytical approach which both the discipline and the problems require.

However, while the environmental scientist-politicians are braying their opinions and prognostications about the eco-crisis from the rooftops, some equally concerned ecologists are getting on, quietly and effectively, with the important task of measuring the metabolism of the world's ecosystems. At present, this effort proceeds largely under the auspices of the International Biological Programme. This volume is an account of a workshop session of ecologists held in 1968 to discuss methods and theory pertaining to investigations of temperate deciduous forest ecosystems.

It provides both the professional biologist and the interested layman with a readable, provocative account of the intellectual and practical joys and difficulties of metering the flows of energy, nutrients and water through such a complex system as a forest. The eighteen chapters, of varied lengths and details, deal with Ecosystem Analysis (4), Primary Production (3), Consumer Organisms (3), Decomposers (2), Nutrient Cycles (3) and Hydrologic Cycles (3).

This collection of papers has launched the *Ecological Studies* series most effectively and those ecologists and others who watch the IBP from the sidelines will look forward with enthusiasm to subsequent volumes. One wonders if a cheaper format would have been more appropriate, reducing the price and bringing the book within the reach of the already over-stressed budgets of graduate students and young scientists.

J. C. RITCHIE

Chairman, Life Sciences Division
Scarborough College
University of Toronto
West Hill, Ont.

Geographical Variation in the Polar Bear, *Ursus maritimus* Phipps

By T. H. Manning. Canadian Wildlife Service, Report Series — No. 13, 27 p. $1.00.

Of all the larger mammals, perhaps none has been subjected to such a confusing array of taxonomic treatments as have the bears. Earlier publications have used *Euarctos* for the black bears, *Thalarctos* for the polar bears, and *Ursus* for the grizzly and brown bears. The generic distinction between *Ursus* and *Euarctos* has been questioned, and most authors now regard them as congeneric. More recently some authors have concluded that *Thalarctos* as a distinct genus is untenable, thus placing all North American bears in the genus *Ursus*. As this concept has not yet been universally accepted, it is unfortunate that at least a short synopsis of the generic status of the polar bear was omitted from this paper.

Past taxonomic treatments have been seriously handicapped by small sample sizes and an in-

adequate knowledge of the normal variations that are related to sex and age. Manning attempts to overcome these problems by amassing as large a sample as possible (628 skulls), separating them into sex and age groups, and subjecting the cranial measurements to exhaustive statistical analysis. The total sample consisted of 240 adults, 106 subadults and 282 young. Of these only slightly more than half had the sex documented. When the specimens were grouped within five geographic regions, the largest samples of known sex were 31 males and 18 females from the Canada-west Greenland area (plus 34 presumed males and 17 presumed females). Unfortunately, the material was not extensive enough for any one population to establish meaningful trends in morphometric characters related to either sexual dimorphism or age, although data on these aspects are considered.

Manning used various statistical methods and tests in attempting to document geographical variation. The use of data from non-adults by adjusting their measurements to average adult length appears to be of questionable value. Moreover, it is highly doubtful that the summary of significant differences in Table 6 can be interpreted as a Duncan's multiple range test that would allow one to decide which of the populations are responsible for observed differences.

A minimum of conclusions is reached in spite of exhaustive statistical analysis. "Criteria previously used to distinguish races of *Ursus maritimus* were examined and found to be of no diagnotis value."

"A cline of increasing skull size from east Greenland westward to Bering Strait is demonstrated."

"The possible origin of the Alaska south population . . . is discussed . . .; it could be considered subspecifically distinct, but is left unnamed pending further investigation."

The regional differences in the size of adult bears is used by the author to postulate that there is no large-scale circumpolar movement and that some populations may be partially isolated by such factors as ancestral breeding and denning areas.

This work makes a much needed contribution to our understanding of morphological variation in polar bears by providing a base for further study.

R. L. PETERSON

Department of Mammalogy
Royal Ontario Museum
Toronto 5, Ontario

Ecology and Physiology of Parasites: A Symposium

Edited by A. M. Fallis. University of Toronto Press, Toronto. 1971. 258 p., illus., $15.00.

This book comprises the twelve papers presented at a symposium held at the University of Toronto in February 1970. The contributors, editor, and publishers are to be congratulated for producing this volume with so little delay. The book is well bound, printed on good quality, glossy paper, and the text is remarkably free from typographic errors. The articles are illustrated with approximately 140 line drawings, photographs, and electron micrographs.

The following topics are covered in comprehensive reviews of 18-36 pages: development and ecology of coccidia and related intracellular parasites (D. M. Hammond), epidemiology of the leishmanias (R. Lainson and J. J. Shaw), morphological and physiological considerations of extracellular blood protozoa (K. Vickerman), helminths as vectors of micro-organisms (D. L. Lee), site-finding behaviour in helminths (M. J. Ulmer), physiology and behaviour of *Entobdella soleae* (G. C. Kearn), and ecology and evolution of blood-sucking Diptera (J. A. Downes). Shorter review papers deal with the following: physiological, morphological and ecological considerations of some microsporidia and gregarines (J. Vavra), microcosm of intestinal helminths (C. P. Read), movement of nematodes (H. R. Wallace), ecology of onchocerciasis (B. O. L. Duke), and *Culex*-host-encephalitis complex (W. C. Reeves). Each paper is followed by the opening remarks of the discussion leader.

Although one objective of the organizers of this symposium was to "interest those in various biological disciplines and professions", this book seems destined to appeal primarily to those working in the fields of animal parasitology and tropical medicine. Most parasitologists will find something of direct application here, and will welcome

the opportunity of being brought up-to-date in some areas peripheral to their own.

Graduate students in parasitology, and those beginning their teaching careers in this field should find these review articles particularly useful. Probably this book could be used to complement a seminar approach to parasitism at the graduate level.

The cost of this volume may deter some potential purchasers. It is unfortunate that this collection of informative papers was not published in a durable paperback edition at perhaps one-third to one-half the present price.

GEORGE G. GIBSON

Canadian Wildlife Service
Department of the Environment
Ottawa, Canada

The Rust Fungi of Cereals, Grasses and Bamboos

By George Baker Cummins. Springer-Verlag, New York. 1971. 570 p. $19.50.

Professor George Cummins has presented taxonomists, mycologists and phytopathologists with a much needed manual of the rust fungi. Rust pathologists in particular will find this book most useful because it offers a logical classification and nomenclature for pathogens in the Uredianles.

In the preface Dr. Cummins suggests that he may have "partially failed" in his principal goal, namely, to develop a system by which rust fungi can be characterized on the basis of their morphology, without dependence on the identity of the host plant. Having tested the manual with respect to a number of Puccinia species of direct concern to me, I am happy to report that the author was unnecessarily modest in his self-evaluation, and has indeed accomplished much of what he set out to do.

Most of the species described are accompanied by illustrations of the various spore forms, and since the drawings are at a uniform magnification throughout the manual, direct comparisons can be made. The frustrations of trying to work with illustrations at different magnifications is something most workers in the field know very well.

The critical part of any such manual is the success with which the average worker is able to use the keys to identify an unknown or unfamiliar species. As the reviewer I felt obliged to test the keys. I'm happy to report that despite my own very limited abilities in mycological sleuthmanship I was able to correctly key out five specimens using both the differential host and morphological keys.

George Cummins' expertise in the rust fungi is once again demonstrated by the publication of this book. It is a useful and well co-ordinated manual which will serve plant pathologists and mycologists for many years to come.

GEORGE FLEISCHMANN

Research Scientist,
Canada Agriculture, Research Station,
Winnipeg, Manitoba.

Systems Analysis and Simulation in Ecology. Volume 1.

B. C. Patten, Ed. Academic Press, New York. 1971. 560 p. $27.50.

This book has been long awaited by ecologists with quantitative interests. A collection of ten related papers by associates and students of Bernard Patten, it is the first real synthesis of ideas and techniques that constitute the growing field of "systems ecology."

The book is directed to relatively sophisticated audiences, and assumes a considerable mathematics background in the reader. It will probably not be suitable as an undergraduate text, or as an overview for people wanting an introduction to the field of mathematical ecology. The collected papers are divided into three sections. The first two chapters, by Patten and Norman Kowal, give an introduction to basic concepts and methods of mathematical model building, focussing on the formulation and solution of dynamic (time dependent) models by analytical and computer methods. Next is a series of three papers on models of single-species populations. F. N. Williams gives a fascinating account of *Chlorella* population dynamics, while Steve Hubbell and Norman Glass examine problems of bioenergetics in sowbugs and largemouth bass. The last five papers present examples of ecosystem simulation. For the most part, these examples deal with the representation of energy flow, and much emphasis is placed on

the relative merits of simple versus detailed models. L. J. Bledsoe and George Van Dyne diverge from the energy theme with models of secondary succession, in which state variables are loosely defined in terms of qualitative changes during succession.

The book is disappointing in several respects, considering its ambitious purpose. Chapter one, billed as a "primer" for ecological modelling, will probably not be of much use except as a review for the experienced worker. The novice reader is immediately faced with complicated equations, and no attempt is made to clarify basic concepts by explaining how symbolic mathematical constructs relate to verbal language as modes of discourse.

Throughout the text we are told that models are best judged in terms of their ability to clarify concepts and fit past observations. It is clear that models can serve as mental crutches, but it is not obvious how models can allow us to bypass basic philosophical objections to the strategy of trying to prove hypotheses rather than disprove them. One can usually force his model or hypothesis to fit some data, even if the model is conceptually absurd.

Much emphasis is placed in several chapters on linear versus nonlinear models as basic classes of ways to represent systems. Real justification for the use of linear models is hard to sort out from the text, and when this justification does appear it is the same as one uses for multiple regression analysis: Linear models are often useful for empirical interpolation. In spite of this admission, several authors somehow seem to regard linear dynamic models as more theoretically meaningful than their linear statistical counter-parts.

Many concepts in systems analysis are barely touched. It was especially disappointing to see only superficial (though often repeated) treatment of stability in dynamical systems. Perhaps this problem will be more fully discussed in volume 2 (due soon).

In spite of its weaknesses, the book is one of the most exciting and information-rich contributions to appear in modern ecological literature. The authors should be proud of their work.

CARL J. WALTERS

Institute of Resource Ecology,
University of British Columbia,
Vancouver 8, B.C.

Man and his Environment

By Don R. Arthur. American Elsevier Publ. Co. Inc., New York 10017, 1969. 218 p. $8.50

Human ecology is such a vast and, now, all-embracing subject that no man, given the limitations of training and capabilities, could do full justice to it. Indeed, the subject has not yet evolved in any full form, in order to marry animal ecology (itself a relatively new and stumbling discipline) to our knowledge of man and his institutions, such as the city.

However, in recent years the greatest need has been to bring the experience, discipline and point of view of the ecologist, considering human evolution and the current human predicament, to popular attention. This book represents a very fine first effort (in the reviewer's experience) to do this.

Many will find it hard going since it is written dryly and not in easy, racing style. But, to offset this, there is a great deal of meat in it which will be invaluable for reference, up to the date of writing (circa 1969).

The book is divided into four parts. The first deals with primate and human evolution, emphasising our unique adaptations. The second, on the environment, deals with nutrient cycles and the nutritional ecology of man including deficiency diseases. This is the shortest, and the weakest, part of the book, because of the lack of writing in this field. It could be helped greatly now by a reading of the issue of *Scientific American* devoted to the biosphere.[1]

The third section deals with the effect of man on our environment including the by now rather familiar topics of erosion, industrial pollution, effluents and pesticides. (To add a Canadian context to this section I would recommend a reading of Brinkhurst and Chant's *"This Good, Good Earth"*[2]).

The last section deals with human populations and population growth and brings us to the main dilemma: the acceleration of population growth in the last few decades, well illustrated by a paragraph (pp. 203-4) and a Table (p 205) devoted to Canada. At the same time the author, with good historical perspective, makes clear that there have been previous population crises in the world, as from hunting to agriculture, and I would add, from the pre-to post-Columbian western world. The modern crisis is merely the most overwhelming and global of them all to date. Writing when

he did, the author could argue logically but not powerfully for the need for birth control as a humane solution to the Malthusian dilemma. Now that man has gone to the moon and looked back on spaceship earth, the argument has gained force. It is not now a question of "should we promote birth control?" but of "how can we most quickly and efficiently gear the governments of the world to a program of universal promotion and availability to their peoples of birth control, at the same time funding massive research into new methods?"[3]

The author (Figure 64) is a little sceptical, by comparison, of space exploration. I would, as a curious scientist, and as an ecologist, look for any way of seeking new raw materials and new places to extend the sphere of living matter. It will be a poor world if the ecologists and engineers are at loggerheads; rather — as in the great clean-up operation of the decade ahead — they can achieve a fruitful cooperation.

"Man and his Environment" is a well-organized book. I can therefore recommend it, as a good textbook for a junior college or university course on human ecology, with the hope that the author will update it with later editions. I would recommend additional Canadian content to be provided by teachers. I would suggest to the general reader to buy it and dip in.

References

[1]**The Biosphere.** Scientific American 223(3), Sept. 1970. Scientific American Inc. 415 Madison Avenue, New York 10017.

[2]**This Good, Good Earth. Our Fight for Survival.** By R. O. Brinkhurst and D. A. Chant. Macmillan of Canada, Toronto 2. 174 p. $7.95

[3]**Life Without Birth.** A Journey through the Third World in Search of the Population Explosion. By Stanley Johnson, Heinemann, London. 364 p. $7.95

DAVID E. SERGEANT

R.R. 1,
Hudson,
Québec

Birds of the Early Explorers in the Northern Pacific

By Theed Pearse. Gray's Publishing Co. Ltd., Box 718, Sidney, B.C. 1968. 275 p. $7.50.

As this book deals with perhaps one of the least known regions on earth, serious amateur and professional ornithologists will find it most interesting. Theed Pearse, Dean of British Columbia's amateur ornithologists, is well-qualified to undertake the research and preparation of this work. He has spent most of his long life studying birds in the British Columbia coast region. The area under study extends from the Strait of Juan de Fuca, northward to the Bering Strait, and south on the Russian side to the Kamchatka Peninsula. The text is largely quotes from the journals of the explorers of the 18th and early 19th Century beginning with such notables as Vitus Bering and Georg Wilhelm Steller. Most expeditions were instructed to pay close attention to the natural history of the new lands. With little or no reference the early naturalists were constantly puzzled by what they saw. The variety of plumages of phalaropes led one observer to record several species of phalarope in one small group! The explorers faced incredible hardships. However, there may have been compensations. There are frequent references to vaste hordes of sea birds, some being new to science. Birds were an important source of food for the natives and explorers. The Spectacled Cormorant (*Phalacrocorax perspicillatus*) being good to eat was probably exterminated by shipwrecked explorers. Eagles were sometimes tamed by the natives of the Aluetians. One observer was amazed to see an eagle sleeping by a hearth in a native hut.

From the journals we get a glimpse of life at sea 200 years ago, we read of teaming wildlife and learn something about the natives of the north Pacific coast. As time has changed so much, we are now indebted to Mr. Pearse for his efforts to preserve the past.

JOHN A. CROSBY

Ottawa, Canada.

Atlas of United States Trees. Volume 1. Conifers and Important Hardwoods.

By Elbert L. Little, Jr. Misc. Publ. No. 1146 U.S. Dept. Agriculture, Forest Service, Washington, D.C. v + 8 p., 200 maps + indexes. $16.75. Available from U.S. Government Printing Office, Washington, D.C. 20402.

Maps of the natural ranges of plants are of interest and value to botanists and naturalists. They show where a plant species grows wild and where a species could be repropagated if destroy-

ed by natural or man-made catastrophes. They indicate where seed may be obtained and suggest the occurrence of possible geographical races. The ranges of related species can be compared and areas in which hybridization is possible can be sought. When species distribution is compared with environmental parameters the interrelationships of the averages and extremes of environmental conditions (temperature, precipitation, latitude, altitude, etc.) and the influences of these factors on the species may be studied. Distribution maps are also useful in species identification and it is not by accident that they are included in many Floras and handbooks.

Many botanists compile distribution maps throughout their lifetime, but all too few such collections reach completion and most are never published. In the Introduction to the Atlas the author tells the story of George B. Sudworth's mapping project which was begun in 1905. Maps of nearly 500 species were prepared. Each dot on the map was numbered and documented in a card file, a surprisingly "modern" approach to distribution mapping. In 1913 Part I of his "Forest Atlas —Geographical Distribution of North American Trees" was published containing maps of 36 species. Between 1915 and 1918 an additional number of his maps were published, but after his untimely death in 1927 hundreds of his unpublished maps were stored and today "their value is chiefly historical." Evidently Dr. Elbert Little, Jr., does not intend that his maps, prepared over 25 years of service with the United States Forest Service, suffer a similar fate.

Volume 1 of the Atlas of United States Trees contains maps of 200 native tree species including all native conifers (94, including 2 shrubs) and 106 important hardwood species. Some of these maps have appeared in other publications but all have been revised and up-dated.

The objective of the Atlas simply is "to map the natural distribution of tree species." To accomplish this end the author draws on information from a wide variety of sources including Floras, manuals, tree-guides, monographs, maps and card files in State herbaria, forest survey maps, vegetation maps, herbarium specimens, and the author's personal field experience. In my opinion, the author's objectives have been admirably achieved and I have already found the Atlas to be of use to me in my research. This Atlas is the most useful collection of maps of American trees yet to be published.

Three base-maps are used, eastern and western United States are at a scale of 1:10,000,000, and a map of North America at a scale of 1:27,000,000. The limits of natural geographic distribution are shown on each map by lines and the area occupied is filled in by stippling or by gray shading.

My main objection to distribution maps of this type is that they are unverifiable. An observed "error" in a distribution map may be explained in a variety of ways, one of which is that map is correct and the critic has inaccurate information. The only options open are to return to the field for first-hand observation, to refer to herbarium specimens, or to accept the word of a "reliable source". In order to achieve verifiability we must return to the mapping technique used by Sudworth in 1905 in which dot maps were prepared with documentation provided for each dot. Dr. Little is correct in pointing out that such an approach would have been very time consuming and would have made the publication of his Atlas virtually impossible. However, the electronic computer has introduced a new element that makes it possible for us to do what Sudworth labouriously did, but with great efficiency. The Atlas of the British Flora, by F. H. Perring and S. M. Walters (published in 1962), and the maps of species distribution in southern Ontario, by Dr. James Soper, are models for future work. It is hoped that now that Dr. Little's generalized distribution maps are available that the next step will involve a re-examination of the edges of species ranges and other critical areas taking advantage of computer technology.

I have two regrets concerning the Atlas. One is that the maps were not redrafted in an attractive style before publication and the second is that the seventh edition of "Native Trees of Canada" (R. C. Hosie, 1969), which contains up-to-date maps prepared by Dr. T. C. Brayshaw, was not available to the author before his maps went to press. The use of hand pencil shading and hand stippling detracts from the work. In terms of appearance this Atlas comes off a poor second when compared with recent atlases published in Europe (*cf.* Eric Hulten, The Circumpolar Plants. Almqvist and Wiksell, Stockholm, 1964). However, the unattractiveness of the maps has an unintentional advantage in that I did not hesitate to correct the Canadian ranges in my copy by hand!

Included in a pocket at the back of the book is a set of transparent overlay maps of the United

States which can be superimposed over the distribution maps to show rivers and lakes, land surface form, topographic relief, hardiness zones, length of growing season, precipitation, climates of the United States, maximum extent of Pleistocene glaciation and major forest types. The potential usefulness of comparing species distributions with these parameters to gain insights into the factors that control species distribution is very great. Unfortunately the overlay maps in my copy do not fit the distribution maps exactly and the map of forest types is useless because the 22 forest types are depicted in different tones of green most of which are indistinguishable from one another.

This Atlas will prove to be of great usefulness to foresters, taxonomists, phytogeographers, and naturalists. We should thank Dr. Little for having the foresight to publish these maps and hope that he will complete the proposed subsequent volumes.

GEORGE W. ARGUS

Canadian Forestry Service
Central Research Forest
Ramsayville, Ontario

Chemotaxonomy of the Leguminosae.

J. B. Harborne, D. Boulter and B. L. Turner [eds.]. Academic Press, London and New York. 1971. 612 p. $31.00

A publisher's note on the jacket of this book states that "The collection of biochemical data bearing on taxonomic problems forms the fundamental idea for this book . . ." Considered within this limited frame of reference this book can probably be said to succeed in its objective. The biochemical aspects of the family are treated very thoroughly and included are chapters of flavonoids, alkaloids, non-protein amino acids, lipids, simple and complex carbohydrates, phytohaemagglutinins, enzymes, proteins and a variety of other micro and macromolecular substances. Chemical constituents isolated from members of the family are frequently listed in uncompromisingly complete fashion; the table of alkaloids runs to 75 pages, the distribution of phytohaemagglutinins occupies 54 and with the necessary documentation supporting these compilations it is not surprising that the general index adds another 54 pages. Techniques and applications are soberly evaluated wth due consideration given to shortcomings and pitfalls that can be encountered. Some chapters contain rather wide ranging reviews but generally speaking contributors address themselves to problems in the Leguminosae.

However, the quotation given above concludes ". . . which represents a novel approach to higher plant systematics". The contradiction between the two parts of this sentence will be apparent to taxonomists. A collection of biochemical data remains just that unless it is comparative and can be integrated with other taxonomic data into some system of classification. In this and every other respect, biochemical characters are the same as other taxonomic characters. This book contains a considerable amount of non-comparative data, which of course satisfies the needs of some workers, but not those of the taxonomist. A unique alkaloid isolated from a single species is not taxonomically useful information. Chemotaxonomists know this and it is mystifying that this volume, which in large part is neither chemotaxonomic nor systematic, but phytochemical, bears the title it does.

In a review of existing classification, phylogeny, etc. that forms an appropriate first chapter, Heywood refers to some of the basic problems of relationships in the family. The stage has been set, but the taxonomist will be disappointed if it is supposed that this systematic purview forms a significant reference point for other contributors in their application of chemical characters to taxonomic problems. It is an odd fact but there is not a single reference to this opening chapter in the whole of the book. All too often where possibly significant chemical data are included, the reader is left to sift out the taxonomic implications for himself. The failure of most contributors to draw conclusions, and the absence of any overall synthesis (something that surely might have been ventured) is indicative of the state of our knowledge. Chemical data are not yet available to provide many fresh insights into relationships in the Leguminosae; the work has yet to become taxonomically selective, oriented to taxonomic problems. There are exceptions of course and future work no doubt will increasingly be undertaken within a more rigorous taxonomic framework than much of that to date. One hopes so anyway.

JOHN G. PACKER

Department of Botany,
The University of Alberta,
Edmonton, Alberta

Use and Conservation of the Biosphere.

No. X, Natural Resources Research Series. Available from UNIPUB, Box 433, New York, N.Y. 10016. 1970. 272 p. $6.00

This book is a documentation of the Intergovernmental Conference on the Rational Use and Conservation of the Biosphere convened by UNESCO in Paris during September 1968. The upcoming United Nations Conference on the Human Environment in Stockholm is a direct result of action taken at the Paris Conference. The first section of the book consist of a series of nine background papers written by eminent world scientists and further reviewed and criticized by other selected world authorities plus the secretariats of UNESCO and FAO. After going through such a rigorous examination it is, needless to say, impossible to site any flaw in the factual content of these papers. The readability, however, seems to have suffered considerably in some cases. I found that I had to set an alarm to go off every five minutes either to wake me up or bring me back to the thread of thought that the author was trying to develop. On occasion, five minutes was far too long a period for the latter.

The first two of the background papers deal with the general themes of *Contemporary Scientific Concepts Relating to the Biosphere* and the *Impacts of Man on the Biosphere*. These were followed by individual papers on the soils and maintenance of their fertility; water resource problems; non-oceanic living aquatic resources; natural vegetation; animal ecology, husbandry and wildlife management; deterioration of the environment and finally, man and his ecosystems. Each paper followed the general format of describing the historical significance and development of the particular problem, and its world wide scope. Often a discussion of various examples and attempted solutions was included to more clearly outline the problem and to suggest future courses of action.

The introductory papers were followed by the final report of the conference. This section summarized the entire proceedings of the conference including short summaries of each of the foregoing papers.

Twenty recommendations resulting from detailed discussions under the themes of Research Problems, Educational Problems and Scientific Policies and Structures bring to a close the formal content of the book. However, as an apparent after thought, the texts of the opening address' given by the Director General's of UNESCO, WHO and FAO, presented at the beginning of the conference, are inserted at the end of the proceedings. The final chapter gives a list of the participants.

In general the book is a good factual documentation of many of ecological problems facing the world today, but it is not the sort of book with which one would want to relax in a comfortable chair. The background papers, which form the main body of the text, offer a concise summary of the use of the world's renewable resources on a global scale and as such the main value of the book will be as a library reference work.

P. B. Dean

Canada Land Inventory.
Department of the Environment,
Ottawa
K1A OM4

Climate, Man and History

By Robert Claiborne. W. W. Norton and Company Inc., New York. 1970. 444 p. $10.95. Available in Canada from George J. McLeod Ltd., Toronto.

Mr. Claiborne starts by indicating that his principal objective in writing this book was to make money; he also indicates that the book will probably annoy a number of scientists. I wish Mr. Claiborne luck in his first aim, as to his second I think he will succeed in adding a large proportion of the intelligent reading public to those he describes as "scientists". He is right to draw attention to the fallibility of scientists and to North American overdependence and worship of them. He is also right that scientists are human beings and that their focus is sometimes a narrow one. The theme of his book is man's social interaction with his climatic environment, a theme on which he "was appalled to discover that there was no single scientific work . . . and precious few that dealt with it even peripherally." Mr. Claiborne never defines what he means by "science" or "scientific work" but he obviously has never heard of social science because if he had he would be aware of writings by authors such as Elsworth Huntingdon who in "Mainsprings of Civilization"

and a variety of other works says much of what Mr. Claiborne is trying to say in a much more acceptable manner.

The book is in four parts; Climate Past and Present, Climate and Emerging Man, Climate and Civilization, and Climate and History. In the first section Claiborne decides that as the available evidence is not really adequate it would be fun to guess, which he proceeds to do with gay abandon. In discussing the present climate the author makes a remarkable statement for one who claims to be skeptical about the opinion of scientists. "We need not conjecture; we *know*". I cannot think of a single climatologist who would share Claiborne's opinion. There is still a great deal to be learned about climate. The description and classification of present climate given is both simplistic and inaccurate. The description of past climates is better but says nothing new and says nothing that has not been better said elsewhere.

Climate and Emerging Man is the theme of the second section and again oversimplification and inaccurary abound. A few examples will serve to illustrate this; "The prologue to . . . evolution occurred before the Glacial Epoch began, in the rich forests of an Equatorial climate or something close to it"; "There, some apes mutated into the first crude version of man"; "We can at any rate say with some certainty that the Glacial Epoch *accelerated* man's evolution"; "The first thing to be said about geological revolutions as a possible cause of glaciation is that their pattern is right"; the list could be prolonged almost indefinitely. Again this section contains nothing new nor are any of the criticisms raised new ones.

Part three deals with climate and civilization. Claiborne argues that civilization in the socio-cultural sense is the third main stage of man's social evolution — the first and second stages being savagery and barbarism. He sees a two stage transition between savagery and civilization which was influenced by special climatic and geographic conditions at each stage. There is little evidence to support such a simplistic model which comes close to the category of pseudo-scientific nonsense. With this kind of framework the section has little to offer the reader except an occasional witticism!

The final section of the book deals with climate and history. The opening sentence is interesting; "A little knowledge is a notoriously dangerous thing, and to no one, I suspect, is it more dangerous than to the academic." Mr. Claiborne should perhaps examine his own writing in the light of his own comment! Later he states ". . . American climates . . . have a clear relationship . . . with an equally characteristic American trait: our addiction to an empirical, pragmatic, cut and dry view of life". This statement appears on page 383 and having read the book to that stage I felt I might as well finish it. The remaining pages did little to alter my opinion that a book of this nature which is a mixture of fact, opinion and fiction is not one that I would recommend to the reader.

D. R. F. TAYLOR

Dept. Geography,
Carleton University,
Ottawa
K1S 5B6

The Environmental Revolution — A Guide for the New Masters of the Earth.

By Max Nicholson. Hodder and Stoughton Ltd., London. 1970. 287 + 60 pages of notes, 32 pages of photographs. Available in Canada from Musson Book Co., Don Mills, Ont. $16.95.

Max Nicholson began his love affair with the environment as a boy birdwatcher. His progress has included the invention and direction of the Nature Conservancy of Great Britain and involvement with the "Countryside in 1970" and IBP programs. He now directs "Land Use Consultants" of London. On the way he has helped to mold ideas on environmental research and management at senior government levels and, perhaps more importantly, for the public. He did much to develop environmental concern and action in the United Kingdom which is a leader in many facets of that work. He has an unique understanding of the history of man's relation to his environment through the ages. He is now working to prevent, in developing countries, some of the environmental mistakes made long ago in the developed ones.

The book is the first by a knowledgeable environmentalist who has had broad experience in big government with political and public realities. It defines the origin of many present environmental problems and suggests workable solutions. Nicholson believes much of modern man's root-

lessness and dissatisfaction has resulted from increasing urbanization and the loss of contact with the world of nature which was an important part of the mainly rural life of earlier ages. Chapter headings include "Man's Use of the Earth", "The Marks of Man", "The British Story", "The American Story", "Where We Stand Now" and "The Way Ahead".

Max Nicholson is optimistic about man's future on the earth. One of his conclusions is "conservation is passing through the phase, critical and testing for all kinds of revolutions, of leaving behind the period of missionary exhortation and protest, and of assuming a responsible and constructive share in the management of the planet . . . it becomes possible only because so many of the inhibitions and resistances within society have been relaxed or neutralized in the general slide away from tradition and custom, and because the kind of aspirations and attitudes underlying the conservation movement largely correspond to the feelings of those who are most keenly critical of various dominant tendencies in modern materialist civilization. The tide is thus favourable".

The book is well made, the illustrations apt, the text clear and tidy. It should be read by anyone concerned with the environment and man's future.

VICTOR E. F. SOLMAN

Canadian Wildlife Service,
Ottawa

An Atlas of Speciation in African Passerine Birds

By B. P. Hall and R. E. Moreau. Foreword by Ernst Mayr. Trustees of the British Museum (Natural History), London, 1970. 423 pp., 1 colour frontispiece and 439 maps. Price in England, £15.

This work has been eagerly awaited by students of African ornithology, who have long known that it was in preparation, and I for one am more than delighted with the final result. It is perhaps a logical follw-up to Moreau's (1966) book on the bird faunas of Africa, though quite different in scope, and it is most unfortunate that ill-health prevented Moreau from doing much more than acting as an advisor for the present work. His death before final publication was a great tragedy and a heavy blow for African ornithology. This is therefore really Mrs. Hall's book, and it is she who is to be congratulated on a magnificent achievement.

The "Atlas" is a first of its kind. This is not just a series of range maps of African passerines (though that in itself would be worthy of publication). Mrs. Hall is concerned with evolution, and her aim here is to illustrate the process of evolution in African birds by the use of maps. This is achieved by plotting on one map the distribution of species believed to be immediately descended from a common ancestor. Mrs. Hall lays great emphasis on the superspecies, which is indeed the most informative unit in speciation research, and the ranges of all members of a superspecies are plotted on the same map. In the case of closely related but sympatric species (part of the definition of a superspecies is that it includes only allopatric species), these are shown on the same map as species groups. The ranges of well-marked subspecies, many of which are considered to be incipient species, are also shown. It is in the selection of these various groupings that Mrs. Hall demonstrates her great insight into the relationships of African birds. Whereas in a few cases I feel that some birds have been squeezed into unlikely groupings because they "must fit somewhere" (and Mrs. Hall herself admits that many of the arrangements are tentative), this can only be regarded as a healthy development because it will stimulate future workers to prove or disprove her ideas. In the main I found myself not only agreeing completely with her arrangements, but being delighted by some of her new approaches, such as the grouping of *Ploceus golandi,* the rare and little-known Sokoke Forest endemic, with *P. weynsi* of Uganda, and the placement of the curious dry-country, tail-wagging "Apalis", *Apalis rufifrons,* (no other *Apalis* wags its tail), in the hitherto monotypic genus *Spiloptila* with *S. clamans,* another dry-country tail-wagger from Sudan and the sub-Saharan *Acacia* belt. In many of her classifications Mrs. Hall places a refreshing emphasis on behavioral characters such as voice — museum skins of African birds have been worked to death by now. It is field workers who will in future solve the problems in relationship indicated in the "Atlas", and perhaps one of its primary achievements is that it has brought so many of these problems to light in such graphic fashion.

As Ernst Mayr says in his foreword, "Here is raw material for an almost endless sequence of studies in biogeography, ecology, and evolution".

The bulk of the book consists of a series of 439 maps depicting the ranges of all African passerine species which are resident on the continent south of 20 degrees N. Over 900 species are involved and one can imagine the amount of work entailed in gathering together all the known localities for each of these birds, let alone plotting them accurately on a map. Distributions are plotted by symbols superimposed on identical maps of Africa, one to a page. The maps are simplified vegetation maps of Africa south of the Sahara and are drawn in fainter outline than the symbols, which thus stand out clearly. The maps are large enough (9" x 7") that each locality symbol stands out clearly, and there is none of the crowding evident in so many range maps. Independent species with no obvious relatives are given whole maps to themselves, and the publishers are to be complimented in not trying to cut corners by compressing unrelated species onto one map in order to save space, as could have been done in a number of cases. This is a handsome book, of "coffee-table" size (15" x 10"), which I predict will one day be a collector's item. Mrs. Hall's interest in superspecies is not confined to Africa; in those cases where African birds are members of a superspecies which is not confined to the continent, the world-wide range of the superspecies is shown on a smaller inset map on the same page, a far-seeing and most informative idea. Accompanying each map, on the same page, is the equally important text, which briefly describes the birds and their habits and ecology, and assesses their relationships. At the end of each family is a summary of its distribution and relationships both within Africa and on a worldwide basis.

Naturally Mrs. Hall has been able to draw up some preliminary findings of her own from this mountain of information, and these are presented both in the introduction and in a table at the end listing, by family and habitat, the number of species in each group, and superspecies, and those species which are considered "independent". One of the most interesting facts to emerge is that fully half of the species mapped in the Atlas are members of superspecies and another 31% belong to species groups, leaving only 18% with no obvious relationships. The presence of so many superspecies draws attention to the tumultuous history of the African avifauna during the recent glaciations when the ranges of so many species were broken up by changes in vegetation. Many of these discrete populations have now reached full specific status, but the fact that they can readily be assigned to superspecies attests to the comparative recentness of this phenomenon

As a final bonus, Mrs. Hall provides us with something which she was certainly under no obligation to do in a work of this kind — a table of English names. It has long been a source of annoyance to amateur ornithologists and even to professionals that the standard works on the birds of South Africa, East Africa, and West Africa have not standardised the English names for birds, which in some cases are almost unrecognisably different. Mrs. Hall has done a great service in listing the English names for every species in her atlas in each of these three works.

It must be evident by now that Mrs. Hall has produced a monumental work, which will be the "Bible" of African ornithologists for years to come. My only regret is that she has no intention, as stated in the introduction and also personally to me, to produce a companion volume on the non-passerines. While I can see that to plot the distribution of, say, herons in Africa might not be particularly instructive from an evolutionary standpoint, and would need treatment on a world basis, nevertheless there are other groups, like the turacos, barbets, and woodpeckers, whose distribution would I suspect prove very illuminating. Mrs. Hall has herself done an admirable study of the francolins, a non-passerine group. Let us hope she will one day change her mind and produce a companion "Atlas of Speciation in African Non-passerine Birds".

This is an expensive book, but the expense does not begin to reflect the amount of work that went into its production or its value to ornithology. It is a book that no student of African ornithology, professional or amateur, can afford to be without.

G. S. KEITH

Dept. Ornithology
American Museum of Natural History
Central Park West at 79th St.
New York, N.Y. 10024

The Voter's Guide to Environmental Politics: Before, During and After the Election

By Garrett De Bell. Ballantine Books, New York. 1970. 300 p. $.95

Environmental politics is what this book is all about. Canadians are soon to be thrown into a federal election. Politicians will be developing their platforms, organizing their constituency supporters and trying to gain your support. Will the Canadian environment be an issue in this forthcoming election? If it isn't, it will be another 4 years before a scheduled election will be called again to allow conservation-minded politicians to seek their place in Ottawa.

The Voter's Guide to Environmental Politics is a book every active environmentalist should be familiar with. The book should be read keeping in mind that the slant is always on how to influence the American politicians, but the principles developed certainly apply to Canadian politics of today. This means that the sections of the book presenting background information on Congressional operations and American environmental agency shortcomings are not too useful, but they are interesting reading for those wishing to compare the two systems — Canadian and American.

The sections relating to the "hows" of influencing the politician are also very appropriate for Canadians. Attention is drawn to the role of the individual citizen outside of his activities in any organization. The importance of the well-informed letter, telegram or other means of communication is explained. Details include the effects these communications have on the politician himself, but more important, the effect they have on the politician's support-staff who have ready access to the elected representative's ear.

Another informative section, which also applies to the Canadian scene, is that dealing with the Regulatory-Industrial Complex. It describes, in detail, what the relatively weak citizens groups, contrasted to the very powerful industrial concerns, have to contend with in decision making systems. The following is an excerpt from *The Voter's Guide:* "In a culture where information is the currency of power, they (the industrial concerns) are consistently able to get early or preferential access to documents, and reach an attentive agency audience." Does this happen in Canada? This section similarly outlines the typical agency structure with its veil of secrecy, unavailable information, and employee's "fear of exposure" preventing him from conversing with the public. The implications of this section are that "the system must change" and there follows suggestions of what must change.

For the eco-activist looking for similarities of programs between the two countries, the *Voter's Guide to Environmental Politics* discusses the environmental issues, one by one, in a very enlightened fashion. Little attention is paid to the generalities of the "state-of-the problem today" syndrome that many treatises adopt. Rather than this, the *Voter's Guide* goes deeper into the root causes, the historical political realities of the problems and uncovers many of the "reasons" why vested interests want to maintain our present ecological suicide path for the sake of their social role. This is most aptly done in demonstrating the vested interests in the transportation industries.

A section is devoted to detailing the inovations required to improve the pesticides regulation procedures and testing protocols to be developed prior to licensing pesticides for use. Another topic — A Bill of Rights for Wildlife — develops the traditional psychology of the good-animal and bad-animal concept as it relates to the relevance of protection of endangered species. Following this is a discussion of the need for citizens' participation in the creation of more wilderness areas and the vested interests that have to be encountered while striving for this goal.

G. Phil Reilly

Pollution Probe Ottawa,
Carleton University,
Ottawa, Canada K1S 5B6

Ontario Federal Members of Parliament Perceptions of Environmental and Socially Related Issues, 1971

By Pollution Probe Ottawa. 1972. 40 p. free*.

This is a partial report on a study undertaken during the Summer of 1971, by members of Pollution Probe Ottawa, and financed by an Opportunities for Youth grant. The data were collected from interviews with the Members, from documentary sources such as the *Parliamentary Guide,* and *Hansard,* and from a questionnaire administered to environmental groups and organizations in the constituencies.

The basic premise of the study is that one way in which environmental issues can be brought to the attention of the policy makers in government is through individual and group approaches to Members of Parliament. While there are serious questions about the ability of the M.P. to influence policy in the Canadian system today, it is likely accurate to view the MP at least as a potential "Environmental Quality Ombudsman" for his constituency. In other words his concern with environmental quality should be oriented primarily to *local* problems and issues within his constituency and only secondarily with governmental policy.

The findings of the Pollution Probe study indicate that most MP's are concerned with environmental problems such as pollution, and generally the documentary evidence bears out the fact that they have from time to time spoken in the House or in committee on the subject. This is not in itself a startling result, for environmental quality problems have acquired a "sacred cow" kind of significance in recent years. Perhaps the weakness of the study is its failure to force MP's to rate the importance of environmental problems against other problems such as unemployment, inflation, poverty, bilingualism and housing. By making it clear to the MP that the interview was to be about environmental problems, it was inevitable that the politically conscious MP would give these a high priority in his responses.

Despite this qualification however, in this study Pollution Probe has laid the groundwork for a change in the attitudes towards solving local problems in environmental quality management. The results of the study will help the individual citizen to identify the "most concerned" men in Parliament, and the interviews themselves will likely have gone some way to educating the MP as to the growing public concern with these sorts of issues.

More studies such as these, and efforts at re-orienting men in public office to the often *local* nature of environmental problems, can hopefully establish continuing links between environmentalists and government at the constituency level. *The publication is free, but a small donation to cover handling and mailing costs (about $1.00) would be appreciated.

MICHAEL WHITTINGTON

Dept. Political Science
Carleton University
Ottawa, Canada K1S 5B6

Nuclear Power and the Public

By H. Foreman Ed. University of Minnesota, Minneapolis, Minn. 1970. 273 p. $9.00. Available in Canada from Copp Clark Co., Toronto.

No other technological product of this century so sharply illustrates the ambivalence of all technology in its capacity for both construction and destruction as atomic energy. Ever since that fateful day on August 6th, 1945, when the first bomb was dropped on Hiroshima, political and scientific controversies have raged about the civil and military development of nuclear power. To build the bomb, scientists had made a "Faustian bargain". Many of these scientists from all over the world and, in particular, the group of international figures who were part of the bomb's development, suffered a kind of trauma over the use to which their greatest creativity had been directed. C. P. Snow, aptly characterized their myopia as a "euphoria of gadgetry". August 6th, 1945, was the end of innocence for science. It was the beginning of a new politics of science and a new ethical commitment for some scientists.

The projects which led to the bomb had also developed the controlled release of atomic energy. One of the major issues in the politics of science facing the U.S.A. after the war was control over atomic energy, whether this should reside in the military or under a civil authority. Scientists from all over the U.S.A. mounted their first major lobby to defeat the bill that would have given control to the military. This saw the birth of the Atomic Energy Commission of the U.S.A. (A.E.C.) But the victory for concerned scientists soon revealed itself as pyrrhic. The purpose of the A.E.C. and the military became indistinguishable. The A.E.C. was in business to sell atomic energy. The Pentagon was the A.E.C.'s biggest customer. The military purpose overcame the civil function. Moreover the A.E.C. was born with a conflict of interests being both the arbiter of standards and the seller of services. In addition there is a most significant fact that the pursuit of military purposes determined the path and the politics of nuclear power.

Right from the beginning a deep-rooted conflict developed between the A.E.C. and independent scientists over the basic issues of public health, radiation protection guidelines and of course, testing nuclear weapons in the atmosphere. It is useless to deny that the conflict had its symbolic as well as its objective aspects. It also re-

flected fundamental conflicts of values which cannot be resolved by objective argument. The history of this conflict is a history of discredibility of the A.E.C. who consistently were forced to retreat leaving a trail of reluctant admissions over previous denials. This lost credibility has never been recovered. The A.E.C. had established a reputation for evasion, defensiveness, complicity and possibly intentional falsities and a role as an open tool of crude state and military purposes in which it prostituted its function of safeguarding public health from the radiation hazard. In the credibility confrontations between scientists of equal capacity, often Nobel Laureates on both sides, it became clear that the A.E.C. was compromised by its duality of function. In the late sixties the environmental debate encompassed the nuclear issue.

It is within this historical background that one can best have insights into the latest episode of controversy over nuclear power. In May 1969, the state of Minnesota passed its own independent regulations regarding radioactive discharges from nuclear power plants; these standards being more stringent than those of the federal agencies and the A.E.C. who supposedly have exclusive jurisdiction in this field. The power company in question has brought a suit against Minnesota to test the legal validity of their act. In October 1969, a symposium was held at the University of Minnesota in which many of the leading protagonists in this issue were assembled to debate the issue. This symposium has now been published. (Nuclear Power and the Public, edited by Harry Foreman, University of Minnesota Press, Minneapolis, 1970). In the symposium the legal questions tended to be submerged by environmental ones.

To review this book one has to make a choice not only about the reading audience i.e. whether they are scientists or laypersons, but also in the selection of issues. The material covers too broad a range of technicality and issue for one to avoid choice. This reviewer will exclude the highly technical and choose those issues that are relevant to the environmental movement because ultimately this is the major question. Even the "energy crisis" which is part of the problem of nuclear power is related to the environment. This approach also does not permit dealing with the personalities involved in the symposium despite their fame in some instances.

Using this scheme one can reduce the questions to four fundamental ones. The first of these relates to social purpose and social value and is often represented by the concepts of cost-benefit and risk-benefit balances in an attempt to measure the net value to society of a particular technology. Attached to this is the separate question of the social needs for energy and the existing and future sources of energy. Thirdly there is the "objective" or scientific aspects involved in the process of technological and social assessment. Finally and in a sense this question pervades all other questions, is the entire spectrum of human values central to the issue of environment. No amount of objectivization can overcome this fundamental issue of social choice and priority. Objectively the issue is not simply pollution (except thermal) and public health. Here the weight of scientific opinion falls in favour of the pushers of nuclear power particularly when compared to fossil-fuel generating plant. This argument is reinforced by the predicted rapid depletion of fossil fuels in the next 30 years (with the exception of coal). Therefore arguing against the rapid spread of nuclear power on a comparative public health risk basis is weak except when the question of the genetic burden is introduced, but this is a problem of the future and our value system is not future oriented.

It is true that for every unit of useable energy produced by a nuclear power plant a larger quantity of waste heat is released to the atmosphere and therefore the level of thermal pollution will increase with an increased nuclear energy role. But assuming we must continue to use energy at existing rates, then the most viable alternative source to fossil fuels of presently developed energy sources, is nuclear. Thus we have very little short-range choice but to continue existing lines of nuclear expansion. Where the entire argument breaks down, of course, is in the assumption of continued exponential consumption of energy by highly industrialized societies such as the U.S.A. and Japan. Another questionable area is the rejection of other energy sources particularly in our medium range planning. The defensible position for environmentalists is to argue that energy is the major creator of environmental degradation no matter what source we use and that the fundamental issue lies in the commitment to growth. If anything, this symposium tends to destroy many of the arguments of anti-nuclear environmentalists when these arguments have been posed in terms of ordinary radioactive hazards, i.e. of pollution and public health. The word ordinary is not chosen idly since a major nuclear power plant

accident or malfunction would involve immense social risk (so high that no private insurance company in the world will insure against such an event). The risk is far greater than that from any other energy producing plant. Thus risk and cost-benefit balances could change in time as traffic accumulates faster than controls, making accidents more probable and in time, absolute. This is critical to the problem of all technological advances. The time factor also brings into prominance the long-range biological hazards of radiation both genetically and in terms of moving through food chains with accumulation and mobility becoming significant factors. Actually the conflict of time-scales is central since the rationale of growth in the technological society is essentially to maximize short-range returns and depend on the "technological fix" to cure or correct longer range social costs. This is why we have an environmental crisis in the beginning. We are hooked on short-range power returns whether economic or political since these are the basic elements of a growth society, as we are hooked by a technological faith that science and technology will always find an answer.

The fact is that the time-scale and the unpredictable social costs of longer-range environmental effects make it impossible to "objectify" our cost-benefit balance. What the A.E.C. and its supporters are really doing is rubber-stamping a system which has built-in commitments or drives to grow and they act as though these were exclusive social purposes not open to question. This tends to de-objectify the assessment procedure since the prior decisions to grow have pre-empted an "objective" cost-benefit balance. The fact that the A.E.C. is able to prove that it can meet the Minnesota standards, but is arguing on principle that these rights reside in a federal authority is deceptive since they have not disavowed their dual role of being judge and jury let alone their cooption by the military. On the whole the prominent environmentalists like Commoner and Tamplin who led the arguments against the A.E.C. did not defend their positions nor attack their opponents too effectively. In part this was because their main lines of argument were pollution and public health rather than the over-riding questions of social purpose and value. For those people in the environmental movement who have uncritically accepted the existing radiation hazard argument or the past history of duplicity and deception of the A.E.C. as proof of the invalidity of their present position, this book will prove shocking. In a narrow scientific sense, the A.E.C. wins the debate at least for now. Actual operational radioactive releases are far less than either national maximum permissible levels or those assumed by such critics as Gofman, Tamplin and Commoner. Industrial safety records in nuclear power plants are among, if not the best, in the country. But none of this effects the basic environmental argument that continued exponential growth of U.S. energy consumption at about 7% per year with the continued lag in effective environmental controls will inevitably lead to an apocalyptic collapse of the environment. Nor does any argument of the A.E.C. or its supporters answer the question of the continued basic world maldistribution of energy consumption rendering the ¾'s of the world of have-not nations permanently incapable of catching up to our average standard of living or levels of consumption. This latter question was not brought up in the symposium by anybody, yet such a continued maldistribution will inevitably lead to major international conflicts. It is these latter two issues that are fundamental to any argument concerning energy and these are applicable to the question of nuclear power. The lesson for the environmental movement is to argue on principle while constantly maintaining its own credibility. We cannot oppose nuclear power because it is intrinsically evil or more hazardous than fossil-fuel generated power, but because it will inevitably become the front line of the blind and suicidal commitment to growth. The strategic value of being opposed to the expansion of nuclear power is enriched by the powerful symbolism attached to the opposition to this technology. This symbolic resistance has great tactical value for the environmental movement, but this does not justify a lack of scientific credibility in the attack on nuclear power.

F. KNELMAN

Department Humanities of Science,
Sir George Williams University,
Montreal 107, Quebec, Canada

Management of Lakes and Ponds

By George W. Bennett. Van Nostrand Reinhold Company, Second Edition. New York. 1971. 375 p. $17.95.

Increased production and yield of freshwater fish can be realized by increased control of fish

and their environments. The possibility of control becomes greater as we progress from natural streams and lakes to reservoirs, to artificially-constructed fish ponds, and ultimately to the fish farm. To this end, the volume brings together in an orderly fashion a great deal of the pertinent information on fisheries management in freshwaters to be found in the ever-increasing number of research papers on the subject. The author clearly indicates that he is not offering recipes for specific action in specific situations. However, he presents principles of fish management, substantiated by liberal reference to research findings, which serve as a sound basis for positive and fruitful action by the fisheries manager. The book will be found of good value as a reference text by the researcher, and as a guide to the layman to the most up-to-date approaches to manipulating pond and small lake environments, and the stocks of fish in them, for maximum yield of desired species. The book deals primarily with warm-water species, notably the centrarchids.

Adverse physical, chemical and biological factors — some natural, but many man-induced — to be encountered by fish in their varied habitats are well reviewed. It is timely that chemical pollutants, such as insecticides, are prominently included. Carrying capacities of waters, growth and reproduction of fish, management procedures (control of numbers, fertilization) and kindred topics are for the most part adequately treated in the main body of the book. The review of stocking procedures is well done and emphasizes that stocking is not the general panacea to cure all fish culture ills as many fish managers still believe and practice. The chapter on fishing and natural mortality is of particular value to the layman. In the review of fish behaviour the angler will find much to improve his catch if he is not too entrenched in his own beliefs as to why fish do or do not bite. Commercial production of sport fish is briefly reviewed.

One fault of the book is that a number of pertinent subjects are dealt with only briefly, such as, for instance, the role of nitrogen as a nutrient in waters. The equating of alkalinity and hardness of water is certainly questionable. The classification of bass lakes as eutrophic gives too narrow a view of the distribution of centrarchids, particularly the smallmouth black bass.

Technically the book is indeed well prepared. Errors such as spelling Oneida Lake, N.Y. as Oneda (p. 120) are rare. The book is illustrated profusely. The book is highly recommended to all involved in fish culture in its many facets.

M. W. Smith

St. Andrews, N.B., Canada

The Biology of Lichens

By Mason E. Hale, Jr., Edward Arnold (Publishers) Ltd., London. 1970. 176 p. $3.50. Available in Canada from Macmillan Co. of Canada, Toronto.

This book which was first published in 1967, was reprinted without alteration in 1970. It is considered by the author to be 'a text intermediate between the semi-popular treatment and the encyclopedic professional level'. This possibly provides the best summary of the book.

The text deals first with the structure of the lichen thallus; the reproductive structures and methods of dispersal. As the book is intended as an introductory work, it might have been helpful if a discussion of the three morphological lichen types; crustose, foliose, and fruicose, had been given before the consideration of the vegetative anatomy of the thallus. The photographs in the first chapter are sometimes rather poor, but are accompanied by excellent line drawings, which are used throughout the book.

The second section of the book deals with the physiology of the thallus, both as a discrete unit and as two components; the alga and the fungus. This is followed by a consideration of symbiosis and an account of the attempts to resynthesise lichen thalli from the algal and fungal partners. The section dealing with physiology must necessarily be without some of the most recent work in this field, but gives a very clear, basic account of the subject.

A chapter dealing with growth, includes notes on the effects of atmospheric pollution and ionising radiation. These two topics have become of increasing importance and interest during the last decade and it is possibly here that the lack of very recent work is most unfortunate. A considerable amount of work is now going on to elucidate the action of pollutants such as sulphur dioxide and heavy metals, on the physiology of the thallus.

Later chapters consider ecology and succession; the use of biochemistry in systematics; and classification and taxonomy. All provide clear and

concise accounts, with information on the original references. In the chapter on lichen chemistry, the presence in the thallus of lichen acids (substances unique to lichens) is considered, and the methods of extracting and recrystallizing these substances, as an aid to taxonomy are considered. However, the photographs illustrating the various acid crystals are not completely satisfactory, as they do not show clearly the characteristics of the crystals.

The final chapter deals with the economic uses and applications of lichens, including such topics as lichens as food; their use as antibiotics; as dyestuffs and in perfumes; their damaging effect on old stained-glass windows; and even their use as stuffing for Egyptian Mummies. This provides a very interesting chapter to end a most useful basic account of the biology of lichens.

ESTHER J. FINEGAN

Biology Department,
Laurentian University,
Sudbury, Ontario.

Forest Gene Resources: Their Conservation and Utilization with Special Reference to the Canadian Spruces

By Laurence Roche. Forest Research Laboratory, Can. Forestry Service, Quebec Region. Quebec. Information Report Q-X-16. 27 p.

Public interest in preserving representative samples of the earth's surface, the biosphere, is steadily increasing world-wide. In Canada many groups are pressing provincial and federal governments to set aside ecological reserves, justified by their cultural-historical and aesthetic values plus their educational and research uses. In support of the same ideas, Dr. Roche has put forward a persuasive argument for the reservation of many forest stands across the country to guard against genetic impoverishment of important trees, such as the spruces and pines, as the technology of logging becomes more and more efficient. He points out that plant breeding relies on variability of populations, so future production of improved forest trees requires protection of geographically-evolved races. Also given is a good review of how gene resources should be utilized; by defining ecological seed zones, establishing superior seed production areas, maintaining a seed registry and siting nurseries in favorable environments. The report can be obtained without cost from the Canadian Forestry Service, and it is recommended to those who are interested in natural areas and their potential uses for tree breeding.

J. S. ROWE

Department Plant Ecology,
University of Saskatchewan,
Saskatoon, Sask., Canada

The Life History and Ecology of the Gray Whale *(Eschrichtius robustus)*

By Dale W. Rice and Allen A. Wolman. American Society of Mammalogists. Special Publication No. 3. 1971 142 p. 38 figs. 18 tables. $5.00.

Of the three publications in this series to date, "The Life History and Ecology of the Gray Whale *(Eschrichtius robustus)*" is the second dealing with a marine mammal. This is perhaps a fair indication of the burgeoning interest in these fascinating creatures which has occurred in recent years. It is also a sign of the times, however, when the biology of many species of marine (and other) mammals is only beginning to be fully documented in the face of dwindling populations and threats of extinction. Happily the gray whale and other species of marine mammals are again increasing in numbers from levels which at the turn of the century appeared to have reached the point of no return. The authors in the present instance even cautiously suggest that commercial harvesting of gray whales might again be considered on a strictly limited, sustained yield basis.

This monograph is the culmination of twelve years of observation of gray whales both in Califorian and Arctic waters and extensive material collected from 316 whales. It has an introductory chapter, a brief review of the nomenclature and an outline of field and laboratory procedures. These are followed by sections on the seasonal migratory cycle; food and feeding; age and growth; the female and male reproductive cycles; predators; parasites and epizoites; population; exploitation; and a summary. There is also an extensive bibliography and a short but useful index.

Each section consists of a detailed account and analysis of the assembled data and is crisply rounded off with discussion and conclusions. The publication is at once of use to the specialist, who

would wish to read it in its entirety, and the non-specialist who could gain a good general knowledge of gray whale biology by simply reading the first and last sections and the discussion and conclusions in between.

The gray whale undergoes the longest migration known for any mammal — a round trip of more than 11,000 miles between the waters of Baja California and the Chukchi Sea. Breeding takes place in winter at the southern end of the range and the feeding grounds are located at the northern extremity. The complete reproductive cycle of females occupies two years and, as it involves feeding, fasting, migrating, mating, calving and lactation, it is an example of a wonderfully adapted sequence of events resulting ultimately in the birth of the young in the most favourable conditions. A completely reliable method of age determination has not yet been established, which is perhaps a little surprising in view of the clearly defined seasonal cycle. The pattern of growth differs from that of other baleen whales in becoming constant after only one year with relatively shorter flippers and a longer tail than at birth. This would seem to be an adaptation to the swimming needs even of the gray whale calf during the long migrations.

One outstanding feature in the biology of the gray whale is the annual passage of large numbers of these spectacular animals within a few miles of easily accessible vantage points along the California coast. Increasing interest of biologists, however, is said to be having deleterious effects through harassment, particularly at calving grounds, by small boats and aircraft carrying over-zealous investigators. These observations focus attention on a broad spectrum of ecological and human factors affecting the survival of one of the world's most attractive mammals and give much food for thought to conservationists at all levels.

The book attains the same very high standard of scholarship and production established by its two predecessors in the series. Both the authors and the American Society of Mammalogists are to be congratulated on a very welcome contribution to marine mammal literature and the presentation of the kind of information which is essential for rational management of the species for their scientific interest and enjoyment to all.

JOHN K. LING

Department of Biology.
Memorial University of Newfoundland,
St. John's, Newfoundland.

Birds of Guatemala

By Hugh C. Land. Livingston Publishing Company, Wynnewood, Pennsylvania. 1970. Numerous range maps, 44 col. pls. by the author and Wayne Trimm, xvi + 381 p. $10.00.

Here at last is a really comprehensive, well-illustrated field guide covering a complete Central American country. "Birds of Guatemala" by the late Hugh Land, is more than just a field guide, containing as it does, a surprising amount of information on Guatemala's rich and colorful avifauna.

Although Guatemala's area is smaller than that of England, no less than 667 bird species have been recorded from within its boundaries. Just recently, species no. 668 was added with the discovery that the plebeian House Sparrow, *Passer domesticus,* has arrived in the country (*See* Thurber 1972, *Auk* 89 (1): 200).

Introductory material includes information on the geography, climate, life zones (Holdridge's system) and their characteristic resident birds, comments on migratory birds, and an ornithological history of the country. Terms used in the text are lucidly explained.

The greater part of the book (322 pp.) is devoted to the species accounts. For each species there is well-chosen and succinctly-presented information organized in such categories as Range, Subspecies, Status in the country, Elevation, Habitat, Description (includes total length and wing chord), and Remarks (a catchall of informative odds and ends). There is a distribution map for each species and on this the numerical status, varying from abundant to rare, is indicated by five degrees of shading. This system has obvious advantages for those parts of the range where the numerical status of the species is known. For areas where the status of the species is unknown, however, the method creates the problem of either having to guess at the appropriate shading to use or the alternative of leaving the unknown area blank even though there may be good reason to assume that the species is found there.

Forty-four color plates depict 294 species, almost all of which are resident Guatemalan birds that do not occur north of Mexico. Half of the plates are by the author, half by Wayne Trimm. Although the latter are aesthetically more pleasing than those done by Land, all serve well their purpose of showing the field appearance of the birds they depict.

The book closes with a useful chapter on bird observation in Guatemala, a 3½ page bibliography, and an index.

Packed with well-chosen information on many aspects of Guatemalan birds, and well illustrated in color, this compact little volume is a must for anyone interested in Middle American birds.

W. EARL GODFREY

Head, Vertebrate Zoology Section,
National Museum of Natural Sciences,
Ottawa, Canada K1A 0M8

Biology of Bats

By W. A. Wimsatt (Ed.). Academic Press, New York. 1970. Vol. 1, 406 p. $25.00. Vol. 2. 400 p. $26.00.

Work on echolocation has stimulated general interest in the Chiroptera, and the use of mist nets has made them easier to obtain for study. These two factors have made bats popular subjects for research as reflected by these two volumes which are part of a multivolume treatise designed to provide a comprehensive and up-to-date summary of our knowledge of the Chiroptera. With these as the stated aims of the series, the first two volumes are certainly evidence that Wimsatt and his colleagues are succeeding.

The two volumes now available include the following chapters: Volume 1 — Bat origins and evolution (G. L. Jepsen), Karyotypic trends in bats (R. J. Baker), The skeletal system, The muscular system, Flight patterns and aerodynamics (T. A. Vaughan), Development : prenatal and postnatal (R. T. Orr), Migrations and homings of bats (D. R. Griffin), Hibernation : ecology and physiological ecology (W. H. Davis), Thermoregulation and metabolism in bats (C. P. Lyman), Urinary system (R. M. Rosenbaum), Volume 2 — Integument and derivatives (W. B. Quay), The central nervous system (O. W. Henson, Jr.), Peripheral nervous system (W. B. Quay), The ear and audition (O. W. Henson, Jr.), Vision, olfaction, taste (R. A. Suthers), Pineal organ (W. B. Quay) and Bats in relation to the health, welfare and economy of man (D. G. Constantine).

In each chapter the information on the subject under consideration is reviewed with comments about the current state of knowledge. The literature reviews are extensive, but not complete (this is not a bibliography of bats), a further reflection of the tremendous amount of material that has been published about bats, most of it in the last 30 years. Of course, there is not a vast quantity of literature for all of the subjects under consideration; e.g. W. B. Quay comments when introducing the Pineal organ, that there is ". . . not a shred of published information . . .".

The introduction of new slang in Chapter 1 of Volume 1 is regrettable and unnecessary. Bats become "chiropts", the Megachiroptera "megabats" and the Microchiroptera, of course, "microbats" — irregardless of the fact that some of the Microchiroptera are much more "mega" than some of the Megachiroptera. I hope that these nicknames will die without propagating.

The books, which come at a time when the available information should and can be collated and reviewed, are a must for anyone contemplating research with bats. By assembling so much relevant material from the literature and combining it with personal expertise, the two volumes are also rendered indispensible to anyone wishing or needing to familiarize himself with bat biology. The recurrent theme in the book is the "diversity of bats". Lengths of the various chapters are usually a reflection of the state of our knowledge of the topics covered, but in all cases, the reader cannot help but be impressed by the paucity of information about this, the second largest order of the Mammalia.

M. B. FENTON

Department of Biology, Carleton University,
Ottawa K1S 5B6
Department of Mammalogy, Royal Ontario Museum.

Infectious Diseases of Wild Mammals

By J. W. Davis, L. H. Karstad and D. O. Trainer [Eds.]. Iowa State University Press, Ames Iowa. 1970. 421 p. $18.00.

This book is a collection of sections describing specific infectious diseases of wild mammals written by many well known wildlife disease investigators. Each section covers one disease, using the same general format, beginning with the history of the disease and then through the etiology, signs, pathology, diagnosis and control. Not all

diseases discussed occur in Canada. The information provided is relatively current and up-to-date.

The viral entities are covered in part I, which fills about half of the book. Part II, covering the bacterial, rickettsial and mycotic agents fills most of the remaining pages. Several blood parasite diseases are also covered in this part. Part III entitled "Neoplastic Diseases" only deals with the skin tumours of cervidae and Part IV is a very short and very general discussion of the toxic agents.

The illustrations are very few in number and of poor quality. Most chapters have a relatively extensive reference list and the index at the end of the book would appear to be adequate.

There has been a longstanding demand for this type of book that summarizes and gathers information on wild mammal diseases from many sources, and the editors have done a reasonably good job in producing 421 pages on a subject that is extensive and always growing larger. The book is a good general reference and can be appreciated by professional and amateurs alike.

The editors have accomplished their purpose as set out in the preface of providing a "single publication where up-to-date information on a specific disease in a wild species could be obtained."

T. W. DUKES

RR # 2
Kemptville, Ontario

The Prairie World

By David F. Costello. Thomas Y. Cromwell Company, New York. 1969. 242 p., 62 illustrations. $9.95. Available in Canada from Fitzhenry and Whiteside Ltd., Don Mills, Ont.

Only a handful of scientists are able to describe the North American prairie in several dimensions. One of these is David Costello. His prairie portrayal is the result of a lifetime of observations and journal recordings. His presentation of several dimensions, including seasonal, ecological, geographical, historical and man's use of grassland is masterfully blended — a unique combination of natural history and species interrelations. In addition, Costello endears himself by writing creatively: "The bleak foreverness of the (winter) landscape . . . arenas of battling bulls and theatres of booming prairie grouse . . . our windmills turned their faces from the wind . . ."

Prairie flora and fauna are amply described by species and niches through six chapters, including plants, mammals, birds, insects, reptiles and amphibians, and migratory forms. Geographical, seasonal and successional items are carried in three chapters. Man and the prairie is the last chapter. Of this information, the historical interludes are the most striking. Scattered neatly throughout the text are the personal observations of a man who came to know the prairie over a lifetime; who saw the sod busted, the "dirty Thirties," and a myriad of other singular and united items of prairie lore.

Discussed are cattle drives, Indian use of prairie plants, the panic and utility of prairie fires, the sod-busters, the homesteaders and the droughts. In amazing detail Costello relates 27 years of observations on a clump of coneflower; 30 years notes on prairie succession from dust bowl to mixed grass; 10 years on a prairie wetland. The reader also learns how to make a windmill work in a dead calm; how many plants can be counted in a square yard of prairie; how to chase water striders across a pond.

Some items are destined to be questioned. Do "ultimate consumers" die of old age? Are badgers becoming rare on the prairies? Are populations of geese lower now than before the White Man's agriculture? Are greater and lesser yellowlegs "relatively rare transient visitors in the prairies?" Is the existence of "exceptionally large geese" still in doubt? Are mallards the "commonest" wild duck? Are droughts truly and finally destructive to the prairie?

Some would argue that carnivores do not die of old age in the wild; that badgers and greater yellowlegs are not rare in the prairies; that most goose populations are now higher than pre-agriculture. It can be argued that breeding populations of giant Canada geese (*Branta canadensis maxima*) are alive and well in Manitoba; that mallards are no longer and perhaps never were the "commonest" wild duck; and that although droughts cause massive devastation of prairie flora and fauna, they also retard wetland succession by drying up invaders. And droughts may play other important roles in prairie maintenance.

The publisher's erratum slip explaining the white faces on black Angus cattle should be amended to include a typographical error on page

12, where the Paleozoic Era would best be described as lasting 365 million years, not 365 billion.

The author suggests, "All things cannot be included in a book of this kind on the prairie." Agreed, but more information on prairie exotics, soils, man's current use of the prairie grassland and the future of the prairie would enrich the work. Many readers would greatly appreciate the author's views, for instance, on fall plowing, summer fallowing and other agricultural practices of questionable benefit.

The final section of the book directs readers to prairie remnants in 10 states. Would that Costello had mentioned the vast network of right-of-ways where delightful strips of prairie can be seen; and the influx of Kentucky bluegrass and smooth bromegrass, and the invasion of annuals in California.

The Prairie World is not, perhaps, a textbook, but it surely would compliment any of them. And for the prairie scholar, or the layman, Costello's work is significant. His own words describe it concisely: "This is a book about relationships."

ROBERT OETTING

Development and Extension Service
Box 11, 139 Tuxedo Blvd
Winnipeg 29, Manitoba

OTHER NEW TITLES

*Assigned for Review.

The Survival Songbook. Jim Morse, and Nancy Mathews. Sierra Club Battle Book. 1971. $4.95. Available in Canada from Clarke Irwin Co., Toronto. Fifty-nine songs and melodies that express ideas more potently than countless speeches on the same subject—environmental and ecological problems. Songs are by Pete Seeger, Tom Lehrer, Tom Paxton, Malvina Reynolds, Don McLean and others.

Synopsis of Animal Classification. R. B. Clark, and A. L. Panchen. Chapman Hall Inc., London. 1971. 134 p. £1.60. A book designed to provide undergraduates with a minimal but adequate grounding in systematics.

A Tourist Guide to Mount McKinley. B. Washburn. Alaska Northwest Publishing Co., Box 4-EEE, Anchorage, Alaska 99503. 1971. 79 p. $4.50 paper, $7.75 hardcover.

What You Can Do About Pollution Now. John Fisher. Longman Canada, Don Mills, Ont. 1971. 404 p. $2.95.

What's Under a Rock. R. Gannon. E. P. Dutton Co., New York. 1971. 122 p. $.95. Explores the little known world under a rock, the history of the rock itself, the soil, weather and hidden organisms and communities that come to light.

***Wild Flowers of the Pyrenees.** W. A. Taylor. Chatto and Windus Co., London. 1971. 103 p. $6.00. Available in Canada from Clarke Irwin Co., Toronto.

About Bats: A Chiropteran Biology Symposium. B. H. Slaughter and D. W. Walton. Southern Methodist University Press, Dallas, Texas. 1970. 339 p. $7.95 paper, $12.50 cloth. Eighteen bat biologists contributed to this 1969 symposium which summarizes current knowledge on the natural history of bats.

Action for Wilderness. Elizabeth Gillette. Sierra Club Battle Book. 1972. $3.50. Available in Canada from Clarke Irwin Co., Toronto. A provocative collection of practical guidelines for identifying wildland resources.

America's Last Wild Horses. Hope Ryden. E. P. Dutton Co., New York. 1970. 311 p. $8.95. History, habits, populations, relations to Indians, and the threats to the existence of the feral horses brought to the U.S. by the Spaniards.

Animal Agression: Selected Readings. C. H. Southwick. Van Nostrand Reinhold Co., New York. 1970. 229 p. $3.95. Fifteen papers, written in the past 3 decades, form this compilation on aggressive behaviour. Included are works by Lorenz and Tinbergen.

The Auk, The Dodo and The Oryx: Vanished and Vanishing Creatures. R. Silverberg. Apollo Editions, New York. 246 p. $1.65. A lively account of myths, legends and facts surrounding notable animals that became extinct in historical times. Some threatened species and a few saved from extinction are included.

Australian Spiders in Colour. Ramon Mascord. Charles E. Tuttle Co., Rutland, Vermont. 1970. 112 p. $6.75. Splendidly illustrated handbook introducing Australia's interesting and varied spider fauna.

Balance and Biosphere. Canadian Broadcasting Corp., Toronto. 1971. 113 p. $2.00. Available from Information Canada, Ottawa. This book contains the text of 7 radio talks and discussions first broadcast by *Ideas,* a program series of the CBC. The participants in this radio symposium on the environmental crisis were Barry Commoner, K. E. F. Watt, Ivan Illich, W. A. Fuller, Paul Ehrlich, James Eayrs, John Arapura, Philip McKenna, and Brewster Kneen.

The Balance of Living: Survival in the Animal World. M. Cooper and L. Mantel. Natural History Press, New York. 1971. $5.95. Highly readable tale of the great variety of adaptation to environment in animals, from butterfly and penguin to amoeba and whale.

***Behaviour of Wolves, Dogs, and Related Canids.** M. W. Fox. Jonathan Cape Co., London. 1971. 214 p. $14.50. Available in Canada from Clarke Irwin Co., Toronto.

A Bibliography of the Coregonid Fishes. K. E. Marshall and C. S. Woods. Fisheries Research Board of Canada Tech. Rep. No. 151. 63 p. Available from FRB Station, 501 University Cres., Winnipeg, Man. R3T 2N6.

*__Biochemical Coevolution.__ K. L. Chambers [Ed.]. Oregon State University Press, Corvallis. 1970. 117 p. $5.00.

The Biology of Lampreys. M. W. Haesiary, and I. C. Potter. Academic Press Inc., New York. 1971. Vol. 1, 426 p. £7.50; 1972. Vol. 2, 400 p. £6.00.

Birds of Rocky Mountain National Park. Allegra Collister. Denver Museum of Natural History, Denver, Colo. 1970. Museum Pictorial No. 18. 64 p. $1.00. The author, who has had years of experience banding birds in the Park, brings up to date bird records from alpine summits down into the Transition Zone.

Chance and Necessity: An Essay on the Natural Philosophy of Modern Biology. Jaques Monod. Alfred Knopf Co., New York. 1971. 204 p. $6.95.

Charles Darwin: The Years of Controversy — The Origin of Species and Its Critics. P. J. Vorzimmer. Temple University Press, Philadelphia, Pa. 1970. 300 p. $12.50. During the 23 years between publication of Origin of Species and his death, Darwin continuously met his critics by revising and re-studying the evidence for his theory of natural selection. Among the primary source materials is Darwin's own collection of reprints with his extensive marginal notes.

The Circumpolar Plants. II. Dicotyledons. Eric Hulten. Almqvist and Wiksells, Boktryckeri Aktiebolag, Uppsala, Sweden. 1970. 463 p.

Clearcut: The Deforestation of America. Nancy Wood. Sierra Club Battle Book. 1971. $2.75. Available in Canada from Clark Irwin Co., Toronto. An examination of the raid on the forest resources. A challenge to government and industry to provide, through forestry reform, a guarantee that the world will forever have wilderness as well as wood products.

Darwin and Huxley in Australia. A. J. Marshall. Hodder and Stoughton Co., London. 1970. 142 p. £2.75.

Dimensions of Environmental Quality. Pierre Dansereau. Sarracenia No. 14. 1971. 109 p. $1.25. Institute d'Urbanisme, Université de Montréal.

Diseases of Fishes. S. F. Sniezko, and H. R. Axelford [Ed.]. Tropical Fish Hobbyist Publications, Jersey City, N.J. 1971. 202 p. $7.95.

Ecology of Colorado Mountains to Arizona Deserts. Helen Moenke. Denver Museum of Natural History, Denver, Colo. 1970. Museum Pictorial No. 20. 96 p. $2.50. Plus a separate of 16 pages showing colour pictures of all life zone exhibits in the Museum's Ecological Hall. $.35.

Ecology and Land Use of the Supply Ponds Natural Area, Branford, Connecticut. Diana S. Cooper, and William L. Hotaling. Yale University School of Forestry, New Haven, Conn. 1970. 56 p. $2.00.

Ecology—The Game of Man and Nature. Urban Systems Inc., Cambridge, Mass. 1971. $10.00.

Ecology of Compost. A Public Involvement Project. D. L. Dindal. New York State Council of Environmental Advisors. State University. College of Forestry, Syracuse University. 1971. 12 p. $10.

Ecology of Estuaries. D. S. McLusky. Heinemann Educational Books Ltd., London. 1971. 144 p. £1.60. The Scholarship Series in Biology.

*__Ecology, Pollution, Environment.__ A. Turk, J. Turk, and J. Wittes. W. B. Saunders Co., Philadelphia, Toronto, London. 1972. 217 p. $4.10.

Energy: Crisis in Power. J. Holdren, and P. Herrera. Sierra Club Battle Book. 1971. $2.75. Available in Canada from Clarke Irwin Co., Toronto. Some experts predict the production of power will continue to double every 10 years while fossil fuels continue to pollute the air, hydroelectric plants destroy rivers and nuclear powers plants threaten every community they serve.

*__L'engagement social du scientifique.__ Jean-Jaques Salomon, Andre DesMarais, and Jean Dorst. Les Presses de l'Université de Montréal, Montreal, Que. 1971. 99 p. $1.00.

Environmental Economics. T. D. Crocker, and A. J. Rogers III. The Dryden Press Inc., Hinsdale, Ill. 1971. 150 p.

Elements of Entomology: An Introduction to the Study of Insects. H. Oldroyd. Universe Books, New York. 1970. 312 p. $7.95.

Families of Fishes of the World: A Checklist and Key. G. U. Lindberg. Nauka, Leningrad. 1971. 470 p. 4 rubles, 4 kopeks. In Russian; scientific names in Latin.

*__The Family Life of Birds.__ H. D. Dossenbach. McGraw Hill, New York. 1971. 192 p. $15.25. Available in Canada from Ryerson Press/McGraw-Hill Canada, Toronto.

Field Guide to the Birds of Southern Africa. O. P. M. Prozesky. Collins Inc., London. 1970. £2.50. The nearly 900 species of birds in the region south of the Zambesi and Cunene Rivers are described. Identifying characters, brief descriptions of habits, voice, habitat and distribution are given for each species; over 400 are illustrated in colour. The author is ornithologist at the Transvaal Museum.

Field Guide to the Larger Mammals of Africa. Jean Dorst. Houghton Mifflin Co., Boston. 1970. 287 p. $8.50. Illustrated by Pierre Dandelot. Larger, in this case, refers to all mammals except bats and the smallest inconspicuous rodents. Identifying characters and habits are given for every mammal species included from south of the Sahara as are a distribution map and a colour drawing.

Field Guide to the Snakes of Southern Africa. V. F. M. Fitzsimons. Collins Pub. Co., London. 1970. 221 p. £2.10. A concise introduction to snakes with a colour key for identification. Each species and subspecies is described, with notes on range and habits.

Fishes. Living Animals. Vol. 4 Part 1. T. S. Rass [Ed.]. Prosveshchenie, Moscow. 1971. 655 p. 4 rubles. 221 text figs. 54 plates, many in colour. Text in Russian with Latin scientific names.

Flying Syringe: Ten Years of Immobilising Wild Animals in Africa. A. M. Harthoorn. Geoffrey Bles Co., London. 1970. 287 p. £3.50.

Functional Morphology and Classification of Teleostean Fishes. W. A. Gosline. University Press of Hawaii, Honolulu. 1971. 208 p.

Fundamentals of Biochemical Pharmacology. Z. M. Bacq, R. Capek, R. Paoletti, and J. Renson [Eds.]. Pergammon Press Inc., New York. 1971. 660 p. $27.00.

Galapagos Islands. A. M. Bailey. Denver Museum of Natural History, Denver, Colo. 1970. Museum Pictorial No. 19. 85 p. $1.50. A narrative of the Museum's 1960 expedition to the Galapagos and explorations by early-day adventurers through the years since Darwin's time.

Hawaii: A Natural History—Geology, Climate, Native Flora and Fauna Above the Shoreline. Sherwin Carlquist. Natural History Press, Garden City, N.J. 1970. 463 p. $19.95.

The Human Environment and Business. Henry Ford II. Weybright and Talley Co., New York. 1970. 64 p. $3.50.

The Insect Societies. E. O. Wilson. Harvard University Press, Cambridge, Mass. 1971. 548 p. $20.00.

An Introduction to the Study of Man. J. Z. Young. Oxford University Press, New York. 1971. 720 p.

The Lysenko Affair. David Joravsky. Harvard University Press, Cambridge, Mass. 1970. 459 p.

A Manual of Acarology. G. W. Krantz. Oregon State University Bookstore, Corvallis, Oregon. 1970. 335 p. $11.45.

Man In Adaptation: The Institutional Framework. Yehudi A. Cohen [Ed.]. Aldine Pub. Co., Chicago. 1971. 478 p. $5.95 paper, $9.75 cloth. **Teachers Manual for Man in Adaptation.** Michael Salovesh. Aldine Pub. Co., Chicago. 1971. 45 p.

Man's Impact on the Climate. W. H. Mathews, W. W. Kellog, and G. D. Robinson [Eds.]. MIT Press, Cambridge, Mass. 1971. 594 p. $19.50.

Marine Food and Game Fishes of California. J. E. Fitch and R. J. Lavenberg. University of Calif. Press, Berkeley. 1971. 180 p. $2.35. California Natural History Guide No. 28.

Mosquitos. J. D. Gillet. Weidenfeld and Nicolson, London. 1971. $5.90.

*__The Mutagenicity of Pesticides: Concepts and Evaluations.__ S. Epstein and M. S. Legator. MIT Press, Cambridge, Mass. 220 p. $12.50.

The Mysterious World of Caves. E. Bauer. Franklin Watts Co., New York. 1971. 130 p. $4.95. Available in Canada from Grolier Pub. Co., Toronto.

Mysteries Beneath the Sea. W. R. Corliss. Thomas Y. Crowell Co., New York. 1970. 170 p. $5.95. A historical review and explanation of the major theories surrounding geological and biological evolution of the oceans. Continental drift and origin of life are included.

Oilspill. W. Marx. Sierra Club Battle Book. 1971. $2.75. Available in Canada from Clarke Irwin Co., Toronto. In 1970, an estimated 1.5 billion gallons of crude and bunker oil spilled into the oceans of the world. Oilspill is about the increasing threat to our environment and gives some new ideas that could help get the world off its hydrocarbon habit before the oceans are irrevocably fouled.

Phylogenesis and Morphogenesis in the Algae. J. F. Fredrick, and R. M. Klein [Eds.]. Annals of the New York Academy of Sciences vol. 175. 1970. 781 p. $25.00.

Pollution: The Effluence of Affluence. F. J. Taylor, P. G. Kettle, and R. G. Putnam [Eds.]. Methuen Publications Ltd., Agincourt, Ont. 1971. 215 p. $3.95 paper.

Pollution. R. S. Leisner and E. J. Kormondy. Foundations for Today vol. 2. Wm. C. Brown Co., Dubuque, Iowa. 85 p. $2.00.

Population and Food. R. S. Leisner, and E. J. Kormondy. Foundations for Today vol. 1. Wm. C. Brown Co., Dubuque, Iowa. 84 p. $1.95.

Presentation of a Modern Natural Classification of Living Fishes. T. S. Rass, and G. U. Lindberg. Voprosi Iktiologii, Adademiya Nauk, Vol. 11, Part 3, No. 68: 380-407. Pub. by Nauka, Moscow. 1971.

Properties and Products of Algae. J. E. Zajic [Ed.]. Plenum Press, New York. 1970. 154 p. $12.50.

Red Salmon, Brown Bear: The Story of an Alaskan Lake.—based on the experiences of Dr. Theodore J. Walker. A. Meyer [Ed.]. World Pub. Co., 1971. 223 p. $8.95. This is the first in the New Explorers Series. It records the adventures and ecological insights gained during seven solitary months spent on the shores of a remote Alaskan lake.

Reflections on a Task: Housing and Urban Development in Canada, 1968. Pierre Dansereau. Sarracenia No. 13. Institute d'Urbanisme, Université de Montréal. 1970. 42 p. $1.25.

Rocks and Minerals for the Collector. Ottawa to North Bay, Ontario, Hull to Waltham, Quebec. Ann P. Sabina. Canada Department of Energy, Mines and Resources, Ottawa. 1971. Resources Paper No. 70-50. 130 p. $2.00.

*__Science and the Future of Man.__ R. L. Carolillano, and J. W. Skehan [Eds.]. MIT Press, Cambridge, Mass. 1970. 196 p. $10.00.

Social Control and Social Change. J. P. Scott, and S. F. Scott. University of Chicago Press, Chicago. 1971. 237 p. $7.95. Topics cover the scientific approaches to the problems of positive social control, the biological basis of social behaviour, changing concepts of sex roles, alienation, and population growth.

Special Ichthyology. G. V. Nikolsky. Visshaya Shchola, Moscow. 1971. 471 p. 1 ruble 84 kopeks.

Stripping. J. Stacks. Sierra Club Battle Book. 1972. $2.95. Available in Canada from Clarke Irwin Co., Toronto. No large-scale industrial activity is more devastating than strip mining. The author describes what is lost when the strippers pass through, analyses the few successes and many failures of reclamation.

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Authors should submit two manuscripts (original and carbon copy), each complete with abstract, tables, and illustrations. Manuscripts should be typewritten on paper measuring 8½ x 11 inches. All text matter, including quotations, footnotes, tables, literature citations and captions for figures should be double-spaced. Words meant to appear in italics should be underlined. Every sheet on the manuscript should be numbered.

Literature citations should be listed alphabetically according to author and should be placed immediately after the main body of the text in all manuscripts except in letters to the editor. In no case should any words be abbreviated; this includes references to tables and figures as well as literature citations.

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The **Style Manual for Biological Journals** is recommended, in general, as a guide to contributors.

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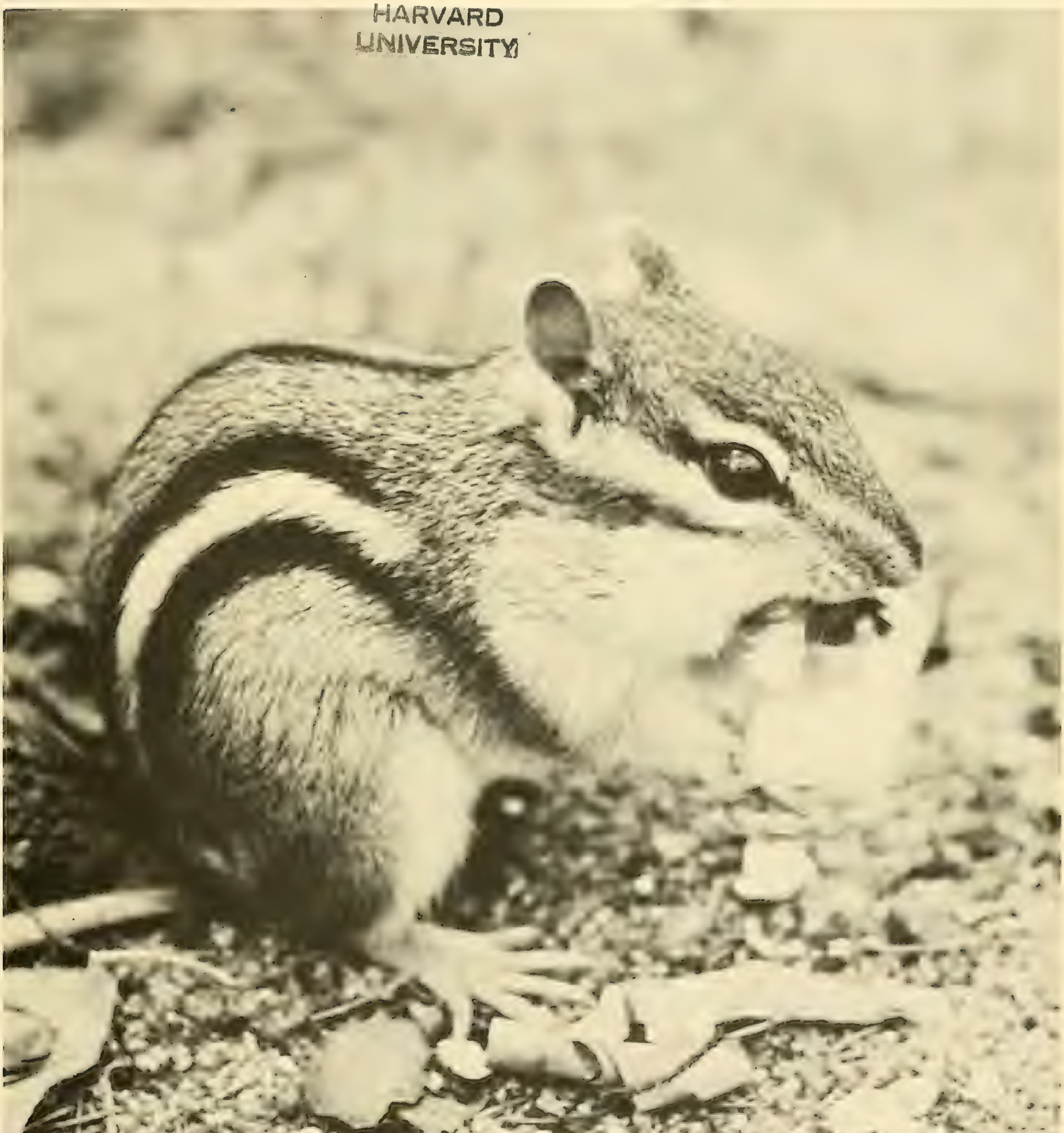

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Cover photograph: An eastern Chipmunk, La Vérendrye Provincial Park, Quebec. See page 253. Photo courtesy of D. F. McAllister.

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Ecological Effects of Snowmobiles

PETER W. NEUMANN AND H. GRAY MERRIAM

Department of Biology, Carleton University, Ottawa, Canada

Abstract. Ecological impact of snowmobiles was studied in the Ottawa area. Snow structural changes by snowmobiles had significant effects on temperature gradients, water holding capacity and melting rate. Snowshoe hare and red fox mobility and distribution also were affected. Snowmobile damage to hardwood saplings and planted pines was significant. Browsing was unaffected except on damaged saplings.

Introduction

Snowmobiles have become an important factor in many Canadian environments including National Parks and greenbelt areas. Numbers of snowmobiles have risen very rapidly (over 500,000 sold in 1969-70 winter), however, little information on their ecological effects is available to those who must manage this new environmental component. This paper presents some preliminary findings which may be helpful until more complete studies can be done.

Materials and Methods

Studies were conducted at four sites, two in Gatineau Park south and east of Pinks Lake, one in a National Capital Commission Greenbelt plantation in the western suburbs of Ottawa, and one private site on the west bank of the Rideau River just north of the Carleton Golf and Yacht Club.

Snow and air temperatures were measured to ± 0.7°C with a Yellow Springs Instruments Model 42 telethermometer and general purpose thermistor probe. Snow temperatures were measured by removing a small vertical core and inserting the thermistor horizontally from the core hole into the snow at specified depths.

Specific gravity was measured by allowing a 300 cc sample of snow to melt at 2°C and, later, according to its coefficient of expansion, adjusting the volume at 2°C up to its 20°C equivalent. Since 1 cc of water at 20°C weighs 1 g, this corrected volume gave an accurate weight of the 300 cc snow sample. Specific gravity was calculated as the weight of the snow sample divided by the weight of an equal volume of water (300 g).

Snow compaction was measured with a blunt, 5.4 cm diameter cylinder with attached containers to which variable weights could be added. The weight of the apparatus and the depth of penetration into the snow were recorded.

Water holding capacity was measured by recording the volume of ice water which could be added to a 300 cc snow sample in a 300 cc container before it overflowed. The container was then covered with a screen cap, inverted and allowed to drain. The differences between volume added and the effluent volume at 5 minutes and at 30 minutes were recorded.

Snow melting rates were measured from a 5.8 cm diameter by 11.2 cm core taken from the surface, as the time taken for these 300 cc samples to melt and drain from a metal cylinder with a perforated bottom.

Animal activity was studied along a straight 366 m section of snowmobile trail about 800 m south of Pinks Lake in Gatineau Park. Preliminary studies indicated that the disturbance of snowshoe hares (*Lepus americana*) and foxes (*Vulpes fulva*) by snowmobiles was mainly within 76 m of the snowmobile trail. Therefore the area within 76 m of each side of the snowmobile trail was considered the treatment area and was contrasted with an equal control area from 76 m out to 152 m on each side. This 304 m by 336 m area was divided into twenty-two 14 m by 366 m rows. One row was on the snowmobile trail and the others were parallel to it. In each row, 6 line transects, each 30.5 m long and 30.5 m apart paralleled the trail. Transects in any row were staggered with those in succeeding rows. A total of 4026 m of transects was distributed

TABLE 1. — Average temperature gradients (°C) in snow compacted by snowmobiles and in untreated snow at three air temperatures (shade).

Depth (cm)	Air −8.0		Air −6.0		Air +3.5	
	Snowmobile	Control	Snowmobile	Control	Snowmobile	Control
1	−8.0	−8.0	−6.0	−5.5	0.0	0.0
5	−7.5	−7.0	−5.0	−5.0	0.0	−0.2
30	−6.0	−5.0	−4.5	−4.0	+0.9	−0.2
50	−5.0	−1.5	−4.0	−0.5	+1.0	−0.4
60	−5.0	−2.0	−4.5	−1.5	+1.0	−1.5

equally between treatment and control areas. Preliminary study indicated that this was the minimum line transect density which would give representative track counts in this area. The number of intersections of snowshoe hare and red fox tracks with these line transects was recorded weekly from January 3 to March 7, 1970.

Damage to saplings was measured along 30.5 m by 1.2 m transects on a snowmobile trail and parallel to it 3 m away. Saplings broken through more than half their cross section and near their base were called severely damaged. All lesser damage was called minor.

Browsing of shrubs was measured along 30.5 m lines immediately beside snowmobile trails and parallel to them at 15, 30 and 60 m and in control areas remote from snowmobile trails but in the same vegetation type.

Results

Temperature gradients in Table 1 show the excellent natural thermal insulation provided by snow (control) and the effect of increased heat conduction in snow after passage of a snowmobile. Under sub-zero ambient air temperatures this increased conduction caused abnormally cold conditions deep in the snow profile. With air temperatures above zero, abnormally high temperatures penetrated to at least 60 cm. Slight irregularities at 50 cm in the two sub-zero control gradients are within instrument error (± 0.7°C).

Specific gravities of snow (Table 2) did not differ significantly between normally sunlit and normally shaded snow but natural snow had much lower specific gravities than snow compacted by snowmobiles. Although the effect was less at 40 cm depth, important increases in specific gravity extended at least to this depth.

Snow compaction values in Table 3 show a distinct threshold on snowmobile trails which allowed no penetration with loading less than 200 grams per square centimeter. Undisturbed snow showed no such threshold and, where comparable, was about seven times less compact as measured here.

TABLE 2. — Average specific gravities of snow in sun and shade, under snowmobile paths and of untreated snow at 2°C air temperature (shade).

Depth (cm)	Snowmobile		Control	
	Sun	Shade	Sun	Shade
0	.56	.53	.19	.14
40	.45	.47	.24	.19

TABLE 3.—Snow compaction on snowmobile paths and in natural snow measured as penetration by a blunt cylinder of variable weight and 22.8 cm² cross section.

Pressure (g/cm²)	Penetration (cm)	
	Snowmobile	Control
50	0.0	0.5
100	0.0	3.3
150	0.0	13.0
200	1.8	14.0

TABLE 4. — Average water holding capacity at saturation (g HOH/100 g snow) of natural snow and of snowmobile paths measured after 5 min and 30 min as described in text.

Depth (cm)	Snowmobile		Control	
	5 min	30 min	5 min	30 min
0	2.0	2.7	6.3	5.7
40	3.0	3.3	5.0	4.3

The slight increases in water holding capacity (Table 4) at 40 cm under snowmobile trails cannot be explained solely in terms of the specific gravity and compaction data and may be related to effects of the added water on crystal structure. Important differences in capacities of natural and snowmobile compacted snow are evident in the measurements where water was retained only five minutes. Differences are smaller where water was retained for 30 minutes but values still are lower under snowmobile trails.

After compaction by snowmobiles, snow melting times increased to as much as double (Table 5). These data are comparable only within pairs because air temperatures differed between pairs.

Measurements of damage to saplings (Table 6) underestimated the damage because the severe damage rating was used only if more than half the cross section of the shrub was broken and the break was near the base on the main stem. Any lesser damage, including removal of bark from tip to base, was called minor. Only saplings less than 2.5 cm diameter at the snow surface were included. Damage measured on trails was due to a single passage by one snowmobile, not repeated use. On trails, only 95 of 440 saplings were undamaged and over half of those undamaged were on Transect 1 which was in loose snow. All other transects were studied after some crusting and showed much higher percentages of damage. On control lines 427 of 475 saplings were undamaged.

TABLE 5. — Rate of melting (min/100 cc) of natural snow and snow from snowmobile paths taken as cores from the surface down to 11.2 cm. Rates are comparable only within pairs due to varying melt temperatures between pairs.

Snowmobile	Control	Difference (%)
53	30	56.5
45	25	55.5
35	18	51.4
32	20	62.4
25	15	60.0

TABLE 6. — Frequency of damage to saplings on paired 30.5 m transects on snowmobile trails and 3 meters from trails.

Transect	On trails			Off trails		
	Severe	Minor	None	Severe	Minor	None
1	38	118	57	0	5	228
2	28	37	14	1	2	93
3	10	16	0	3	9	10
4	23	42	16	4	15	62
5	19	14	8	2	7	34
	118	227	95	10	38	427
			440			475

Even with the conservatively biased classification, over 25 per cent of all saplings on trails were damaged severely and probably would die subsequently. Data in Table 6 are from the Rideau River study area and are mainly red maple saplings.

Fifteen transects were studied in a National Capital Commission Greenbelt area, west of Ottawa, which was reforested with young pines. Seventy per cent of the trees in the area were damaged by snowmobiles. Leaders were broken from 27 of 147 trees.

In Gatineau Park on repeatedly used, hard packed, snowmobile trails, no vegetation remained above the snow surface.

Effect of snowmobiles on animal activity was measured directly by counting the number of red fox and snowshoe hare tracks which intersected equal densities of line transects within 76 m and between 76 and 152 m of a regularly used snowmobile trail in Gatineau

TABLE 7. — Red fox and snowshoe hare activity within 76 m and from 77 to 152 m on each side of a snowmobile trail.

Date (1970)	Record duration	Mean daily no. transects crossed			
		Red Fox		Snowshoe Hare	
		0 to 76 m	77 to 152 m	0 to 76 m	77 to 152 m
1/3	8	0.88	0.50	2.13	3.00
1/10	4	1.00	0.50	2.25	3.25
1/17	6	1.33	0.67	2.50	3.80
1/24	2	1.00	0.50	2.00	3.00
1/31	4	0.75	0.25	1.75	2.50
2/7	4	1.00	0.50	2.00	3.25
2/14	3	1.00	0.67	2.33	3.00
2/21	4	0.75	0.50	2.00	2.75
2/28	2	1.00	0.50	2.00	3.00
3/7	3	0.33	0.33	1.25	1.67
$\overline{X}$		0.90	0.49	2.02	2.92
S		0.420	0.129	0.343	0.447

Park (see METHODS). It was found that 3.7 cm of new snow obliterated previous tracks in this area. Therefore, the duration over which the last 3.7 cm of snow had accumulated was the number of days during which current animal tracks had been made. This number was used to obtain means from absolute number of tracks which crossed transects at each count (Table 7). Red fox activity was nearly twice as great within 76 m of the snowmobile trail as it was beyond that zone ($t = 2.68$, $p = .025$). Snowshoe hare activity was significantly lower within 76 m of the snowmobile trail than it was from 76 to 152 m ($t = 2.44$, $p = .05$). These patterns were strict, they were not reversed in any individual counts from January to March.

Ease of travel which might be provided if animals followed snowmobile trails was measured as depth of penetration on and off the snowmobile trail by tracks of the same animal. Penetrations (cm) on and off three repeatedly used snowmobile trails were: 2.0 and 14.5 for two dogs, 1.1 and 8.4 for six foxes, 0.5 and 2.5 for four snowshoe hares, and 1.5 and 20.9 for three humans.

Effect of snowmobiles on browsing herbivores (mainly snowshoe hares and cottontails)

TABLE 8. — Average number of shrubs browsed by all species along 30.5 m line transects at increasing distances on both sides of snowmobile trails and along control transects remote from snowmobile trails.

Distance from trail (m.)	Rideau River Area	Gatineua Park Area
1	1.3	2.7
15	3.3	1.7
30	4.7	3.3
60	5.7	3.7
Control	4.3	4.0

was measured by counting the number of plants which had been browsed by all species (Table 8). The average number of browsed plants directly beside the trails in the Rideau River area was low but there is no significant relationship between browsing counts and distance from snowmobile trails.

Discussion

Temperature gradients within the snow were made less steep by passage of snowmobiles. With subzero temperatures this extended low temperatures down into the snow. With the air at +3.5°C, above zero temperatures extended deeper in the profile. These temperature changes, especially those below freezing, could have important effects on organisms inhabiting subnivean environments. A temperature decrease of 3°C in this range would increase the metabolic demand of a 20 gram short-tailed shrew (*Blarina brevicauda*) by about 25 calories per hour (Randolph, 1971).

Changes in thermal conduction and convection which resulted in temperature profile differences after snowmobile passage are related to compaction. Specific gravities of deep snow doubled at least and at the surface specific gravities were tripled by snowmobiles. Because thermal conductivity of snow is proportional to the square of specific gravity, this increased thermal conductivity by four and by nine times respectively (Formosov, 1946). Density increases also may affect small mammals directly. W. O. Pruitt, Jr. (1971) estimates that density increases due to snowmobiles may cause

significant increases in energy costs of burrowing by small mammals.

The changes in pore space and crystal structure which caused these changes in specific gravity also altered the potential water holding capacity. When saturated briefly the water holding capacity of snow from snowmobile trails was reduced 70 per cent near the surface and 40 per cent mid-way down the profile. Structural changes in the snow after longer periods of saturation reduced these differences to 52 per cent and 23 per cent respectively. During spring melt these effects could significantly reduce the ability of snow to slow runoff and to moderate the effects of thawing.

Due to increased density and consequent changes in thermal conduction and crystal structure, snowmobile trails melt more slowly and maintain a partial gas seal over the substrate during spring melt. Effects on vegetation are similar to those of backyard skating rinks. Wanek (1971) has evidence that bacterial decomposers and litter decomposition may be significantly affected. Effects on animals in the litter and soil need study.

Direct mechanical effects of snowmobiles on vegetation at and above snow surface can be severe. After only a single passage by a snowmobile over 78 per cent of the saplings on the trail were damaged, nearly 27 per cent of them seriously enough to cause a high probability of death. Rigid woody stems up to 2.5 cm diameter were very susceptible to damage. In surface packed or crusted snow, they usually were snapped off. More pliable stems bent and sprang back after passage of a snowmobile but often the metal cleats of the drive belt removed most of the bark from the stems' upper surfaces. Stems which escaped damage in the Rideau River area inevitably were under other damaged stems and protected by them. Frequency of damage was not significantly different between deciduous saplings and planted conifers, although deformation of growth patterns was likely to be more severe in conifers which had leaders removed. Under excessive snow weighting, such as in the winter of 1970-71, it also is possible that snowmobile passage between trees contributed to breakage of lower branches from stems of pines. On trails which received high intensities of use, all vegetation above the compacted snow surface was mechanically eradicated. Clearly, snowmobile trails could severely damage or eliminate small plots of specific vegetative types and where preservation of such vegetation is desired, snowmobile trails should be prohibited. However, the ecological meaning of snowmobile damage to vegetation is not easy to generalize. Thinning of some vegetation stands could be desirable but we suspect that those areas are infrequently used by snowmobiles precisely because of the vegetation density.

Browsing animals used some of the vegetation broken down by snowmobiles. In the Rideau River area, half of the plants broken by snowmobiles had been browsed at the tips. In the Gatineau area where shrubs were less available, over 62 per cent of the broken plants had been browsed. No other clear relationship between snowmobiles and browsing is evident.

Activity data for snowshoe hares indicate that these browsers do avoid snowmobile trails. Their mean activity from January to March was significantly lower within 76 m of a repeatedly used trail. However, red fox activity was much greater close to the same snowmobile trail. Apparently this resulted from the increased mobility which foxes gained by travelling on the snowmobile trail. Foxes followed the snowmobile track for as much as 150 meters. Where they left the track, their penetration into the snow increased by about 85 per cent. Dogs and humans bogged down similarly and snowshoe hares somewhat less when they left a compacted trail. Penetrometer measurements at 200 g/cm^2 also indicated about 87 per cent greater penetration off the snowmobile track. Kelsall and Prescott (1971) give information on ungulate track penetration in natural snow with a similar range of densities.

It is difficult to predict whether the snowmobile effects studied here will affect whole ecosystems. It is not safe to assume that system effects will be in simple proportion to the area covered by snowmobile trails. Many other

ecological effects have not yet been well documented and much more study is required before the overall ecological meaning of snowmobile use can be clarified. However, management of snowmobiles as a factor in the human environment should not await this purely ecological information.[1]

Acknowledgments

We thank James F. Hickman and Earl R. Young for collection of some of the field data.

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[1]A recent paper by Schmid (1971) was not available to the authors but should be consulted.

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Native Swans Wintering on Vancouver Island over the Period 1969-71

IAN D. SMITH and DONALD A. BLOOD[1]
British Columbia Fish and Wildlife Branch, Court House, Nanaimo

Abstract. Counts of wintering native swans indicated that the Vancouver Island population increased by 129 per cent over the period 1969-1971, and that the 1970-71 population contained a minimum of 1,076 birds. It is believed that most of the birds are Trumpeter Swans. Over the same period, the proportion of cygnets has been 22 per cent, 26 percent, and 25 per cent. Major wintering areas appear to be centered about sheltered salt-water estuaries. The proportion of birds wintering on these estuaries was highest during the most severe winter over the counting period.

Introduction

In an attempt to determine the status of native swans wintering on Vancouver Island, counts were conducted over the three years ending in the spring of 1971. Purpose of the counts was to gain information on total number of birds, areas of major concentration, the proportion of cygnets, and population trends.

Methods

The majority of observations were made from fixed-wing aircraft, although ground observations were also included in the inventory where aerial counts were not available. Aerial observations were favoured because they tended to reduce errors caused by swans shifting location from time to time.

During the first two winters the counts covered only portions of Vancouver Island, but in the 1970-71 winter an attempt was made to census the entire area by covering all regions where swans had previously been reported, or which seemed likely to contain swans. Virtually all ice-free bodies of water on Vancouver Island were covered during the three years, but in some cases counting conditions were poor. The counts were largely conducted in February, although observations from other months were included in some cases.

[1]Present Address (Junior author): Saskatchewan Fisheries and Wildlife Branch, Saskatoon.

Results and Discussion

Population Size

The 1970-71 inventory indicated that there were a minimum of 1,076 native swans wintering on Vancouver Island, distributed relatively uniformly about the island where suitable habitat existed (Figure 1). The reliability of this estimate is not known, since daily counts in some areas indicate that the birds shift about to a considerable extent; since it is not known how many wintering areas were missed; and since in two instances (involving a total of 20 swans) it was necessary to include estimates not based upon direct observation in the winter of 1970-71. However, we believe that the estimate of 1,076 is not greatly in error, and that it is probably somewhat conservative.

Specific identification of the wintering population has not been determined, but we believe that it is made up mainly of Trumpeter Swans (*Olor buccinator*), although it is possible that some Whistling Swans (*O. columbianus*) also winter on Vancouver Island. Estimates of the Trumpeter Swan population in North America have risen sharply since Munro (1962) and Banko and Mackay (1964) estimated the number of birds to be about 1,500. Hansen *et al.* (1971) estimated that in 1968 there were 3,400 or more Trumpeter Swans on the breeding grounds in Alaska, from which at least part of the Vancouver Island wintering population is apparently derived (Hansen *et al.* 1971). Thus a wintering Trumpeter Swan population in excess of 1,000 on Vancouver Island would not seem unrealistic.

All physical evidence indicates that the Vancouver Island birds are mainly Trumpeters. In the few cases where it was possible for the authors to make positive identification, either from dead swans turned over to us or from vocalization of live birds, the swans were identi-

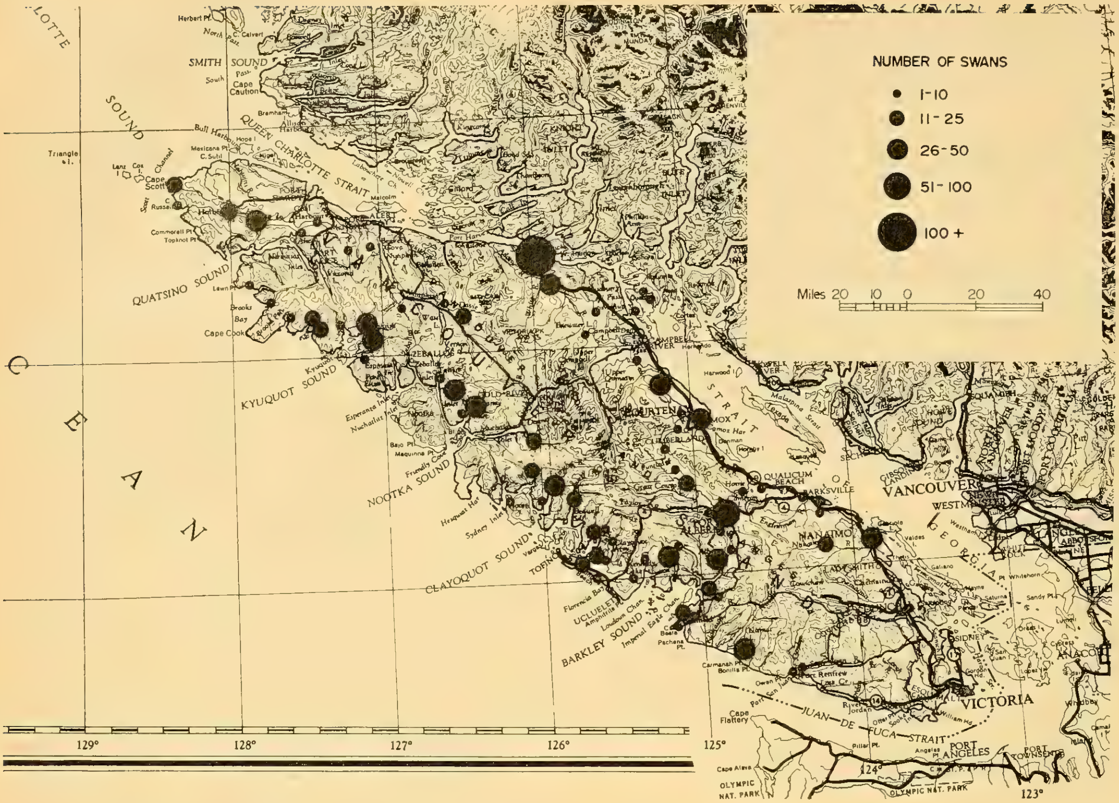

FIGURE 1. Distribution of swans wintering on Vancouver Island in 1970-71.

fied as Trumpeters. Similarly, wintering swans from Vancouver Island which have come into the possession of other biologists have been identified as Trumpeters. Cowan (1946) reported on the death of a Trumpeter near Qualicum, and Munro (1949) regarded thirteen swans which died near Nanaimo as Trumpeters. In addition Benson (1964) investigated the death of seventeen swans in the Campbell River area, and recorded them as Trumpeters. The large size of most swans observed by us in the wild also suggested that they were Trumpeters.

There is evidence (Hansen *et al.* 1971) to suggest that Whistling Swan cygnets lose their grey plumage considerably earlier than Trumpeter Swan cygnets. Our experience suggests that on Vancouver Island the majority of cygnets are still in grey plumage at the time of the northward migration (Table 1), indicating that they are Trumpeters.

Distribution ranges given by standard ornithological works also indicate that the Vancouver Island swans would be mainly Trumpeters. Peterson (1961) states that Whistlers winter in California, Oregon, Utah and Wyoming, and Godfrey (1966) cites their winter range as ". . . the Pacific and Atlantic coast of the United States from Washington to California and from Maryland to North Carolina." Guiguet (1958) reports however that three Whistlers wintered at Victoria in 1952, and cautions that while most swans seen wintering on the southern coastlines of British Columbia are regarded as Trumpeters, ". . . correct identification requires close scrutiny, rather than an assumption of species based on time and place."

TABLE 1. — Changes in the apparent proportion of cygnets by month among native swans wintering on Vancouver Island in 1970-71. These data were derived by totalling all classified observations on Vancouver Island during that period.

Month	Adults	Cygnets	Percent Cygnets
November	63	25	28%
December	216	107	33
January	265	94	26
February	1004	335	25
March	35	10	22

The pattern of fall migration lends further credence to the belief that swans wintering on Vancouver Island are Trumpeters. Whistling swans in the Pacific Flyway leave their arctic breeding grounds during September, ". . . and by the end of October most of them have arrived or are well on the way to the wintering-grounds" (Guiguet, 1958). Swans wintering on Vancouver Island, however, usually begin to arrive in late October or early November and build up to peak numbers in December and January as their Alaska breeding range and north-coastal wintering range becomes increasingly inhospitable.

We feel then, that the weight of evidence favours our assumption that the great majority of the swans counted in our surveys on Vancouver Island were Trumpeters.

Population Trends

Comparison of totals from areas checked in more than one year indicate that the wintering population is growing substantially (Table 2).

TABLE 2. — Indicated increases in numbers of native swans wintering on Vancouver Island, through comparison of areas checked in the winters of 1968-69 and 1970-71.

Area	1968–69	1970–71	Total Increase	Percent Increase
East Coast	187	353	166	89%
Alberni Area	41	176	135	329
Part of West Coast	113	253	140	124
Total	341	782	441	129

In the southern and eastern portions of the island there was a 34 per cent increase in swans between 1968-69 and 1969-70, while comparisons between 1969-70 and 1970-71 indicate a further 81 per cent increase.

While sampling error has probably been large (as indicated by the fact that the apparent rates of increase differed widely throughout various portions of the island), we conclude that the population has increased significantly over the three-year period. Longer term estimates for one of the more significant wintering estuaries, the mouth of the Salmon River at Kelsey Bay, also suggest a significant increase. Benson (1964) reported that 15-20 Trumpeters wintered there, Luckhurst (1967) saw 40 there, and our surveys indicated 79 in 1969, 107 in 1970, and 140 in 1971. These figures indicate an average annual rate of increase of over thirty per cent.

The indicated rates of increase for Kelsey Bay and for the larger regions of Vancouver Island appear too great to be accounted for solely by reproduction. It appears that both increased survival rates and immigration from other wintering areas are involved.

Proportion of Cygnets

The proportion of cygnets in the swan population wintering on Vancouver Island remained relatively constant over the three-year period. Approximately 22 per cent of the swans were cygnets in 1968-69, 26 per cent in 1969-70, and 25 per cent in 1970-71. There was also very little difference between areas in the proportion of cygnets.

Data presented by Banko (1960) for the Wyoming-Montana-Idaho Trumpeter population indicate that the proportion of cygnets in that area declined from about 40% in the mid 1930's when the population was low and rapidly expanding, to about 16% in the late 1950's when the population had leveled off and saturated its breeding habitat. During the period the total swan population increased at an average rate of ten per cent annually. The data suggest that the swan population that winters on Vancouver Island is an expanding one which has not yet fully saturated its breeding habitat.

TABLE 3. — Changes in the proportion of native swans wintering in different habitat types on Vancouver Island in three successive years.

Year	Winter Weather	Salt-water Estuary	Lake or River
1968–69	very cold	79%	21%
1969–70	very mild	64	36
1970–71	moderate in most areas near sea level	63	37

Description of Wintering Areas

Major wintering areas occurred at Nanaimo (51 birds), Comox (74), Kelsey Bay (140), Holberg (60), Cheewhat River (48), Alberni (83), Herbert Inlet (51), Tlupana Inlet (78) and Kyuquot Sound (81). In all cases these figures represent the results of a single count, or the usual total from several counts. On any given day it is likely that the number of swans counted would not equal the totals presented above because of shifting about of birds, but the general relationships between wintering areas are thought to remain relatively constant.

All but one of these major areas of concentration include an extensive and sheltered salt-water estuary, on which it is likely that the birds depend in the most critical periods of winter when the bodies of fresh water are frozen. The only exception is the Cheewhat River system, which has extensive fresh-water marshes and which has a comparatively mild winter climate because of its proximity to the west coast. The importance of estuaries to the swan population is indicated by Table 3, which compares the location of birds during an extremely cold winter (1968-69), an extremely mild winter (1969-70), and a winter during which prolonged cold did not occur at sea level (1970-71).

In view of the importance of estuaries to wintering Trumpeter Swans, the Vancouver Island Trumpeters appear endangered by the accelerating process of estuarine deterioration in that area. Important causes of estuarine depreciation include industrial waste disposal, land fills, dredging, harbor development, log-booming activities, residential development, and other related causes. In view of the historical, ecological, and aesthetic value of the Trumpeter Swan, it is hoped that governments and regional planning authorities will recognize the winter requirements of this species and accommodate them in any future development plans for estuarine habitats.

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Research on Canadian Mammals

Anne Innis Dagg

Department of Mammalogy, Royal Ontario Museum

Abstract. Fourteen well-known refereed journals or series over the past 40 years were searched for articles on Canadian mammals. Of the 639 published, 74% had appeared in one of four journals. Of the total, 262 dealt with big game species. The most researched mammal, the caribou, was studied in 57 papers but many species had had no work done on them. Of the five research categories studied, the universities have done the most research, especially recently, probably because of the recent increase in scientific grant money. Most researchers have written only one paper, but 12 men have been much more prolific. Most work has been done in the Canadian north and west of Quebec. Research fields of increasing importance include pollution, populations, techniques, ecology and habitat, behaviour, reproduction and anatomy and physiology.

Introduction

Canada is a vast country and there are few zoologists in it, so relatively little is known about our native mammals. Virtually no research at all has been done on some species, and the work on other groups has not been integrated. In an attempt to document the research that has been done, and to provide a base which may guide future research, the present literature review has been undertaken. The study points out the increase in mammal research recently; in 1915, only ten research articles on Canadian mammals appeared in print (Walker, 1917), while in 1970, 51 were published in the journals searched.

Method

Eleven refereed zoological and wildlife journals and the scientific publications of the Canadian Wildlife Service and of the two important research museums were checked over the past forty years and notes made on every article about wild mammals in Canada that appeared in them. For each article the following information was coded: the date of publication; the authors and their location and employers; the region where the studies were done; what grant

Table 1

Numbers of papers on Canadian mammals published in 14 major journals and series

	Date of First Volume	1931–40	1941–50	1951–60	1961–70	Total
Canadian Field-Naturalist & predecessors	1884	30	45	23	46	144
Journal of Mammalogy	1919	28	29	31	40	128
Canadian Journal of Zoology and precursor	1929	3	8	23	86	120
Journal of Wildlife Management	1937	0	5	27	47	79
National Museum of Canada publications	1913	3	7	15	7	32
Transactions of the North American Wildlife Conference and successor	1936	2	11	11	4	28
Canadian Wildlife Service	1950	–	1	14	12	27
Arctic	1948	–	0	7	11	18
Royal Ontario Museum publications	1928	2	6	6	2	16
American Midland Naturalist	1909	3	1	2	9	15
Naturaliste Canadien	1869	2	2	2	7	13
Ecology	1920	1	1	1	8	11
American Zoologist	1961	–	–	–	4	4
Ecological Monographs	1931	0	2	0	2	4
		74	118	162	285	639

TABLE 2
Canadian mammal articles published by the five research groups during the past four decades.

	1931–40	1941–50	1951–60	1961–70	Total
Universities	8	26	42	148	224
National government	14	46	52	82	194
Provincial government	12	13	44	53	122
Non-Canadians	27	19	21	30	97
Unaffiliated Canadians	6	14	6	4	30
	67	118	165	317	667[1]

[1]The values are sometimes higher than in Table 1 because if several authors of different institutions co-authored one paper, this paper was included under each institution category.

TABLE 3
Number of authors who published the articles appearing in the last four decades

	Single author	Two authors	More than two authors	Total number of papers
1931–40	95%	5%	0	74
1941–50	82%	17%	1%	118
1951–60	69%	23%	8%	162
1961–70	62%	27%	11%	285
				639

TABLE 4
Number of authors writing a given number of papers.

Number of Papers	Number of Authors	Number of Papers	Number of Authors
1	246	14	0
2	48	15	3
3	24	16	0
4	18	17	1
5	7	18	0
6	12	19	0
7	4	20	0
8	2	21	1
9	1	22	0
10	0	23	1
11	2		
12	3		
13	0	49	1

money was used in the work; whether it was practical or theoretical; and the species and subject matter of the research. A species or mammal group was coded if at least two pages were devoted to it. The subject matter was sometimes varied in one paper, but usually the main subject and at most the two most representative subjects were coded for each article.

Several limitations were placed on the material tabulated. No papers of less than one and a half pages were coded, as these usually dealt with casual observations rather than with major research efforts. As well, articles emphasizing parasites rather than the host mammals were also omitted, as were those dealing with individuals that had been bred in captivity.

Results and Discussion

Of the 639 articles tabulated, 74% appeared in four journals — the Canadian Field-Naturalist, the Journal of Mammalogy, the Canadian Journal of Zoology and the Journal of Wildlife Management (Table 1). (Hein, 1967) also noted preferential grouping in his literature review.) The Canadian Field-Naturalist published the most mammalian articles. Although the Canadian Journal of Zoology published almost twice as many articles as any other journal during the last decade, it printed very few during its early years.

Table 2, which like Table 1 notes the great increase in research in mammals during the last decade, groups the zoologists who did the work into five categories. The Federal government employees increased their output noticeably during the last decade, while the Provincial workers did so during the past 20 years. The non-Canadians were much more prolific than any other group during the thirties, but their research has remained fairly constant over the years since then. These workers mostly came either from the United States or from Great Britain. The output of non-affiliated Canadians has also not increased recently and has generally been low. The research at the Canadian universities has grown more dramatically than that of any of the other groups, especially during the last decade.

TABLE 5. — Number of papers from each type of institution and from each region where the author(s) lived.

	Universities	Federal Government (where stationed)	Provincial Government	Non-affiliated Canadian
Maritime Provinces	14	4	23	1
Quebec	36	11	8	1
Ontario	56	72	54	10
Prairie Provinces	43	42	14	11
British Columbia	84	7	28	6
North*	0	14	0	0

*In this paper "north" refers to areas in Canada north of 58° N Latitude.

TABLE 6. — Number of papers from each type of institution and the region where the work was done.

	Universities	Federal Government	Provincial Government	Non-Canadian	Unaffiliated Canadian	Total
Maritime Provinces	19	18	21	24	1	83
Quebec	14	6	8	5	1	34
Ontario	48	3	49	14	8	122
Prairie Provinces	48	58	17	14	11	148
British Columbia	54	14	24	18	6	116
North	43	88	2	18	1	152

The dramatic upsurge of mammalian research at the universities is probably correlated with the increased number of research grants available. In all, ten commercial grants and 117 government grants (mostly federal) were acknowledged in the papers. Of the government grants one was acknowledged in the thirties, two in the forties, 27 in the fifties and 87 in the last decade. All of the commercial grants were available only in the last decade.

The need to attract grant money may have stimulated the increase in multi-author research projects (Table 3). Papers written by a single author decreased from 95% to 62% between the first and last decades of this study and those

TABLE 7. — Types of mammals studied by institutions or groups.

	Universities	Federal Government	Provincial Government	Non-Canadian	Unaffiliated Canadian	Total	Number of Papers
Game species	30%	40%	47%	16%	18%	34%	262
Fur-bearers	18%	22%	23%	34%	36%	22%	182
Lagomorphs	7%	5%	8%	10%	10%	6%	55
Marine species	14%	9%	4%	6%	0	10%	71
Small species	31%	24%	18%	34%	36%	28%	214
	100%	100%	100%	100%	100%	100%	—
Number of papers	243	265	127	110	39		784[1]

[1]This value is greater than that of the total number of papers because many research efforts have two or more papers dealing with different types of mammals.

written by three or more authors increased from 0 to 11%.

The vast majority of the authors worked on only one paper and only a few authors have written a large number (Table 4). These include I. McT. Cowan who authored or co-authored 49 of the papers in this study, and R. M. Anderson, B. E. Baker, A. W. F. Banfield, A. W. Cameron, A. De Vos, R. Y. Edwards, W. A. Fuller, R. L. Peterson, A. L. Rand, J. D. Soper and A. J. Wood who wrote between 11 and 24 of them. Almost all of the papers dealt with field or lab work; only 35 were in large part or entirely theoretical in nature.

The regions from which the workers came varied considerably (Table 5). The University of British Columbia has produced far more research than have other universities, including those of far longer standing. This is largely because of the impetus of I. McT. Cowan. Federal employees from Ontario have been most productive, but this is somewhat misleading as many work out of Ottawa, the national capital. Provincial workers from Ontario have published the most papers, followed by the less populated regions of British Columbia and the Maritime Provinces. Provincial employees of Quebec have published little.

The provincial employees and the unaffiliated Canadians usually did their research in the region in which they lived. The other workers were more likely to go farther afield and especially into northern Canada. The research done on northern mammals is greater than that done on any other group (Table 6). Least is known about mammals living in Quebec.

The National and Provincial Parks, where animals are protected from human interference, would seem to be ideal regions for research to be carried out. However, of the work reported in these papers only 63 projects were done in the Federal Parks and only 31 in the Provincial Parks.

The game animals, defined as ungulates and bears, have a greater economic and aesthetic value than the other types and the government employees have tended to concentrate on them (Table 7). The smaller species, all squirrel-size or smaller and uneconomic, have received less than average government attention. This was also true for marine species (cetaceans and pinnipeds) which were studied only on the three coastal areas of Canada. Together these two latter groups include many times the species included in the game category, so that very little work has been done on most mammals of Canada. The fur-bearing species (all carnivores but bears, plus beaver and muskrat) have economic value to trappers and to predator control workers but relatively less research has been done on them by the governments than by non-Canadians and unaffiliated Canadians. The lagomorph research has dealt primarily not with these species as animals for recreational hunting but with the phenomenon of cyclic numbers in the varying hare.

The types of research undertaken on mammals were similar throughout the time of this study with the exception of pollution research, which was only begun very recently (Table 8). Papers on distribution, behaviour and general

TABLE 8

Numbers of papers dealing with a particular subject matter during the four decades

	1931–40	1941–50	1951–60	1961–70	Total
Distribution	26	36	43	39	144
Behaviour (movements, food, activity etc.)	6	13	23	73	115
General biology	20	29	35	26	110
Anatomy, physiology, weights and growth	6	6	20	64	96
Populations	6	10	21	28	65
Techniques (aging, trapping etc.)	3	2	12	45	62
Taxonomy	11	21	13	9	54
Productivity and management	2	12	19	10	43
Reproduction, litters and genetics	3	5	10	23	41
Ecology and habitat	1	5	10	18	34
Disease, accidents and parasites	3	5	8	10	26
Pollution	0	0	0	3	3

TABLE 9

Canadian species on which four or more papers have been published in the journals and series considered.

		Number of papers (or 2+ pages per paper)
Insectivora		
Blarina brevicauda	shorttail shrew	6
Chiroptera		
Myotis lucifugus	little brown bat	7
Lagomorpha		
Lepus americanus	snowshoe hare	27
Lepus europaeus	European hare	4
Rodentia		
Castor canadensis	beaver	25
Peromyscus maniculatus	deer mouse	19
Ondatra zibethicus	muskrat	16
Peromyscus leucopus	white-footed mouse	14
Microtus pennsylvanicus	meadow vole	14
Tamiasciurus hudsonicus	red squirrel	8
Clethrionomys gapperi	redback vole	6
Eutamias minimus	least chipmunk	4
Carnivora		
Canis lupus	timber wolf	18
Vulpes vulpes	red fox	10
Martes americana	marten	9
Ursus maritimus	polar bear	8
Ursus arctos	brown bear	7
Lynx canadensis	lynx	7
Ursus americanus	black bear	5
Martes pennanti	fisher	5
Pinnipedia		
Pagophilus groenlandicus	harp seal	6
Odobenus rosmarus	walrus	6
Artiodactyla		
Rangifer tarandus	caribou	57
Alces alces	moose	40
Odocoileus hemionus	mule deer	16
Odocoileus virginianus	whitetail deer	14
Cervus canadensis	elk	11
Bison bison	bison	11
Ovis canadensis	bighorn sheep	9
Ovibos moschatus	muskox	7
Oreamnos americanus	mountain goat	6
Antilocapra americana	pronghorn	6

biology have been most numerous. Despite the recent increases in numbers of papers published, work on distribution, taxonomy, general biology and productivity and management has not increased to any extent. Thus the importance of these fields has decreased relative to other fields. These other fields, in which papers have been appearing in increasing numbers recently, include studies on populations, techniques, ecology and habitat, behaviour, reproduction and anatomy and physiology.

Table 9 shows that although some Canadian species have been studied in depth (57 papers on the caribou), others have received scant attention and others virtually none at all. For example, there are 28 other species of rodents, 9 of carnivores and 7 of cetaceans that have had only one, two or three papers devoted to them in the publications considered. These include the wolverine, a largely Canadian species, and the gray squirrel, a very common one, with one paper each. Nothing has been published there on most bats or on Canadian moles. There are, of course, short nature notes, good articles scattered in other journals, and a few books about various wildlife species in Canada, but these few additions do not invalidate the general impression given by Table 9 that little research has been done on most Canadian mammals.

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A Study of the Boreal Owl in Southern Ontario with Particular Reference to the Irruption of 1968-69

PAUL M. CATLING

104 Victoria Park Ave., Toronto, Ontario

Abstract. Boreal Owls, *Aegolius funereus richardsoni,* are reported to move south of their boreal forest breeding range in large numbers during the winter at irregular intervals. In eastern North America these irruptions have occurred in the winters of 1922-23, 1954-55, 1962-63, 1965-66, and 1968-69; and have often been coincident with southward movements of Great Gray and Hawk Owls which also inhabit the boreal forest region. There is some variation in magnitude, direction, and distance travelled southward. The three most recent irruptions seem to have occurred in late winter, reaching a peak in late February and early March. Return flight to the north seems to occur in April and May, at a time when nesting should be well advanced, suggesting that the vagrants do not breed in the following season. Both sexes appear to be involved in southward movements. Information concerning habitat, winter residence, roosting situations, inter- and intra-specific relationships, and behaviour, was obtained in a detailed study of the most recent incursion (1968-69). Data on the food of this species are summarized, and feeding behaviour is considered. Analysis of ca. 75 pellets showed *Microtus pennsylvanicus* to be the most important prey species of Boreal Owls in southern Ontario in the late winter of 1968-69. Size and contents of pellets are discussed.

Introduction

The Boreal Owl, *Aegolius funereus richardsoni,* referred to by Taverner (1922) as "the rarest of Canadian owls", is generally confined to its breeding range (Fig. 1), which includes the boreal forest region of Canada, south to the north shore of Lake Superior (Godfrey, 1966, p. 220). During the winter, at irregular intervals, these owls have irrupted ca. 400 miles southward into the transition and deciduous forest regions of eastern North America; areas comprised largely of farmlands interspersed with woodlots.

The following account will briefly document and discuss the major southward irruptions that have taken place in eastern North America, and also report on a study conducted in southern Ontario during the most recent of these irruptions.

[1]Irregular southward movements of northern birds have traditionally been referred to as "flights".

Previous Irruptions

A single Boreal Owl is seen in southern Ontario about once in every four or five years (discounting the major movements). Such records of only one or two owls per winter cannot be considered as evidence of an emigration. Only those references to a definite influx, or to a relatively large number of owls, are considered here.

A card on file at the National Museum of Canada suggests that a small scale southward movement of Boreal Owls may have occurred during the winter of 1906-07 (Edward White). Great Gray Owls, *Strix nebulosa*, were unusually prevalent in southern Ontario during that winter, but there are only two, somewhat indirect records of Boreal Owls (Eifrig, 1907; Fleming, 1913).

There is no doubt that a major southward irruption of Boreal Owls occurred during the winter of 1922-23. This "flight"[1] extended from Maine (Bent, 1938, p. 226) through Ontario (Fleming, 1930, pp. 68-69; Bent, 1938, p. 227) to Michigan (Bent, 1938, p. 227) and Minnesota (Roberts, 1932, p. 632). In southern Ontario "the first Toronto bird was taken on December 22 and they continued to be taken in the immediate vicinity of the city till January 25" (Fleming, 1930, p. 68). Within this period, twelve were brought to Toronto taxidermist Oliver Spanner (Baillie, 1969). As with some of the later incursions of Boreal Owls, this one was coincident with a flight of Great Gray Owls (Fleming, 1930, p. 68).

There appears to have been a definite but smaller southward movement of Boreal Owls during the winter of 1954-55 (W. Earl Godfrey, pers. comm.). Baillie (1955) remarked that more than usual had been seen, and cited seven observations from southern Ontario, the south-

FIGURE 1. Boreal Owl (*Aegolius funereus richardsoni*) photographed near Clarkson during March 1969.

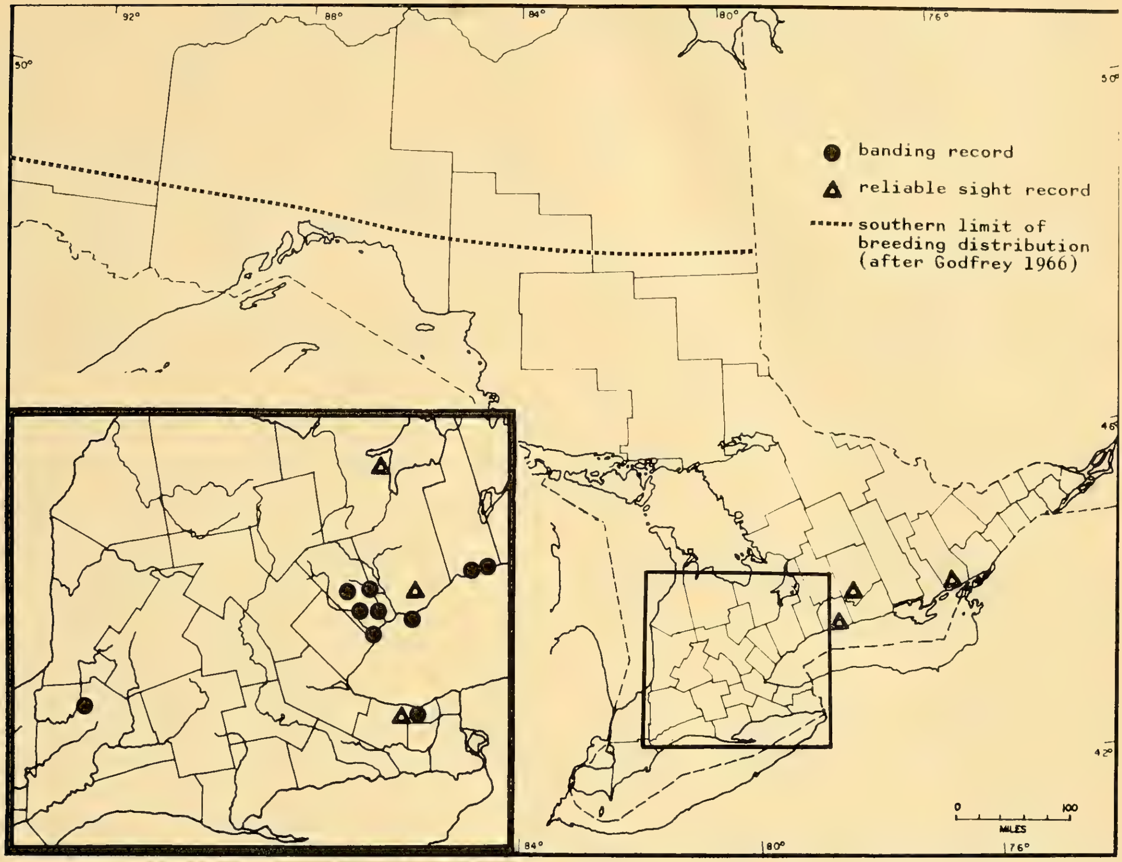

FIGURE 2. Occurrence of Boreal Owls in southern Ontario during the winter of 1968-69, and southern limit of known breeding distribution in the province.

ernmost being at Richmond Hill, north of Toronto. Also, several were encountered at Ottawa (W. Earl Godfrey, pers. comm.), which were not recorded by Baillie (loc. cit.). Two other Boreal Owls were reported from Quebec (Nichols, 1955). It seems that this irruption was more or less confined to Ontario. "There was a noticeable southward flight of pale Horned Owls" during the same winter (Baillie, loc. cit.).

In 1963 another flight of Boreal Owls occurred in Ontario between 2 January and 25 March, when there were reports from at least 10 separate localities in the south (Goodwin, 1963, pp. 32-33). This flight was not as noticeable elsewhere, there being only two reports from northern Minnesota and three from New England. A major irruption of Hawk Owls, *Surnia ulula caparoch,* occurred in the east during the same winter (Aud. Field Notes, 17(3)).

During the winter of 1965-66, "a late winter invasion of Boreal Owls took place in northern Minnesota, mostly along the shore of Lake Superior . . . with 14 reports of apparently different birds from January 16 to April 6" (Bernard, 1966, p. 427). Seventeen were banded at Whitefish Point, Michigan, between 10 May and 20 May 1966, which was the highest number in five years of banding (Kelley and Roberts, 1971), and probably represented the return of this influx to the north. During that winter only one Boreal Owl was reported from southern Ontario at Pickering, Ontario Co. on 22 January. An unprece-

TABLE 1. — Wing chord, tail length, and culnost measurements (in mm.) of Boreal Owls banded in southern Ontario in 1969.

Date	Location	Wing chord	Tail	Culnost
16 Feb. 69	Summerville	160	105	14
21 Feb. ,,	Jordan Harbour	170	105	–
23 Feb. ,,	Clarkson	185	108	14.5
23 Feb. ,,	Clarkson	182	105	14.5
25 Feb. ,,	Clairville	160	95	12.5
25 Feb. ,,	Snelgrove	172	101	12
8 March ,,	Whitby	163	98	12.5
9 March ,,	Summerville	167	105	12.5
9 March ,,	Brittania	167	95	12
12 April ,,	Ajax	180	110	14

dented flight of Great Gray Owls took place in Ontario and the western Great Lakes regions, but notably did not appear to penetrate south of a line from Owen Sound to Presqu'ile Park in Ontario (Goodwin, 1966, p. 417).

1968-69 Irruption

During the winter of 1968-69, there was a movement of Boreal Owls that "appeared even more extensive and was perhaps the heaviest since the winter of 1922-23" (Goodwin, 1969, p. 475). This invasion was particularly evident in southern Ontario, but not noticeable in New York where the species is much rarer (records summarized by Rusk (1962); Post (1965), and Kemnitzer (1965)). There were eight reports from several northern Minnesota counties, and single birds were reported in New Brunswick, Nova Scotia, and New Jersey (Plunkett, 1969, p. 445). The first southern Ontario bird was seen in the valley of Etobicoke Creek near Summerville, Peel Co., on December 26 (Goodwin, 1969, p. 475). None was observed thereafter until 25 January, when one was reported from Kingston (Goodwin, 1969, p. 475). On 5 February a Boreal Owl was found in Willowdale (Toronto) and taken to Riverdale Zoo (records of Toronto Ornithological Club). There was a record from Peterborough on 7 February (Goodwin, 1969, p. 475), and from Bowmanville on 8 February (K. McKeever, pers. comm.). A Boreal Owl was observed at Ailsa Craig, Middlesex Co., on 10 February; banded on 9 March (R. John, pers. comm.); and seen intermittantly until 17 March (Goodwin, 1969, p. 475). On 15 February, one was found near Clarkson, Peel Co. (K. Taylor, pers, comm.), where two were banded on 23 February, both of which were recaptured, one on 1 and 16 March, the other on 9 March. A Boreal Owl was observed in the one-acre pine plantation at Clarkson on many other dates after 15 February, the last being 17 March (G. Rousseau, pers. comm.). One was banded near Summerville on 16 February. Also on this date a Boreal Owl was found in a ½ acre spruce-pine plantation near Clairville (R. Scovell, pers. comm.) from where there were reports until 25 February, when one was banded. Another was banded on 21 February in Louth twp., Lincoln Co., (J. G. Woods, pers. comm.), where one was seen from 22-25 February and on 16 March (Goodwin, 1969, p. 475). On 25 February one was banded near Heart Lake, Peel Co. One was found on Toronto Island, York Co., on 25 February (Goodwin, 1969, p. 475) where one was banded on 26 February (T. Curry, pers. comm.), and seen intermittently within a few hundred yards of the banding site until 22 March (J. L. Baillie, pers. comm.). Another was found at Ajax, Ontario Co., on 26 February (Goodwin, 1969, p. 475) and near Balls Falls, Lincoln Co., on 2 March (G. Rousseau, pers. comm.). I banded a Boreal Owl at Whitby, Ontario Co., on 8 March; and one near Summerville, and also one near Brittania, Peel Co., on 9 March. One was found dead near a barn entrance in Innisfil twp., Simcoe Co., on 15 March (C. MacFady, pers. comm.). One was seen at Pickering Beach from 16 to 19 March (Long, 1969). One banded at Ajax on 12 April was the last record. This 1968-69 irruption of Boreal Owls into southern Ontario was accompanied by a major invasion of Great Gray Owls in Manitoba (Nero, 1969).

It appears from wing chord measurements (see Table 1) that both male and female owls were involved in the 1968-69 incursion. Godfrey (1966) found the average wing chord measurements of males to be 165.9 mm; and

of females, 173.6 mm. My own measurements of Ontario specimens in the Royal Ontario Museum resulted in a mean wing chord measurement of 165.3 mm for males and 170.3 mm for females (based on 8 random selections of each sex). Five Boreal Owls banded in 1969 had wing chord measurements of less than 167 mm and were probably males, while five had wing chord measurements in excess of 170 mm and were probably females. There was no pattern of occurrence with respect to habitat or time obvious in either of the sexes. Culnost and tail length measurements serve as further indications of sex. Measurements of museum specimens taken south of the breeding range in other years also suggest that both sexes usually take part in southward movements.

During the winters of 1969-70 and 1970-71, there were only a few reports of Boreal Owls far south of their breeding grounds.

Mysterud (1970) has suggested that the population of *Aegolius funereus* may be periodically highly non-residential, and assumes the movements to be multi-annual, with a dispersion pattern related to the cyclic nature and regional variability in production of small mammal biomass. It appears that in the case of the Boreal Owl (subsp. *richardsoni*) these movements are usually within the boreal forest region, but are occasionally directed southward on a large scale. As Mysterud (loc. cit.) points out, the frequency with which emigrations and movements occur may be greatly underestimated; especially because this species is so inconspicuous. It seems possible that a few minor southward irruptions have passed unnoticed. However, the foregoing probably represents a more or less complete account of the extensive southward movements, which have been apparent not only to active naturalists, but also to taxidermists, farmers, and city dwellers.

Trends in Southward Flights

Certain trends are apparent in these southward flights. They are often coincident with southward movements of Great Gray and Hawk Owls which also inhabit the boreal forest region. The three most recent flights seem to have occurred in late winter, reaching a peak in February and March. They vary in their magnitude, direction, and distance travelled southward. Both sexes appear to be involved. Return flight to the north seems to occur in April and May. Kelley and Roberts (1971) suggest that "Boreal Owls may have a cyclical pattern of occurrence" on Whitefish Point (which is south of their breeding range), and report their spring occurrence there in four out of five consecutive years, with a total of 39 being banded between 22 April and 22 May. Several nest records suggest that breeding birds have a full clutch by late April. It appears therefore that the birds taking part in southward winter movements are non-breeding during the following season, although they may be sexually mature (Mebs, 1966).

Habitat, Winter Residence and Roosting Situations

During the winter of 1968-69, Boreal Owls were found most often, and consistently in small areas (½ to several acres) of mixed woodlands, or white pine, *Pinus strobus* L., and (or) spruce, *Picea* sp., plantations. These were typically surrounded by old farmlands not recently cultivated. The woodlands provided cover for daily roosting, while the surrounding grassy fields comprised an ideal habitat for meadow mice, the most important prey species.

The continuous presence of owls in areas less than an acre in extent, in several different locations, suggests that some of them became temporarily resident. This was proven through banding and subsequent recapture at the location near Clarkson. There two Boreal Owls were found in a dense stand of white pine (see Fig. 3) surrounded mostly by scrub-meadow, with some marsh and deciduous-mixed woodland. Both (545-13108 and 545-13109) were banded on 23 February. One (545-13109) was recaptured on 1 March (7 days after banding) ca. 150 yards north of the banding site, and again recaptured on 16 March (22 days after banding) ca. 100 yards west of the original banding site. The other (545-13108) was recaptured on 9 March (15 days after banding) ca. 30 yards northwest of the original banding site.

FIGURE 3. White pine (*Pinus strobus*) plantation near Clarkson used as a daily roosting place by Boreal Owls. On 23 February 1969, a Boreal Owl was found on each side of the opening to the left within 10′ of the ground in thick foliage. Both these owls were found subsequently (up to three weeks later) suggesting temporary residence.

Mumford and Zusi (1958), and Austing (1958) have similarly proven that Saw-whet Owls, *Aegolius acadicus*, may establish a "territory" during the winter, and that individuals may be found consistently in the same roosting trees.

In a number of locations, Boreal Owls were seen only once despite extensive searching. Apparently many were wandering and did not become resident.

Some roosting places of Boreal Owls were found to be similar to those generally selected by the Saw-whet Owl. Locations 6-10 ft from the ground with thick concealing foliage, especially those providing a canopy above, are typical. Owls were found in pine, spruce, hemlock, and cedar. Only one was discovered in deciduous growth directly beneath the canopy of a vine tangle over hawthorn. A few of the owls were found roosting in more open locations, up to 30 ft from the ground within mature pine and spruce plantations. These roosting sites had been used in the past by Long-eared Owls (Asio otus), but never by Saw-whets. It appeared that Boreal Owls, in the study area, were not as selective as either Saw-

whets or Long-eared Owls have been, but tend more toward the Saw-whet type of roosting site.

The habit of entering buildings mentioned by Bent (1938, p. 225) was not noticed during the winter of 1968-69. However, there are references to this in Ontario: W. J. Stevenson, Oshawa taxidermist, informed J. L. Baillie (Feb. 1928) that two or three of these owls were brought to him in 1913 by a boy who caught them in a barn (J. L. Baillie, pers. comm.). Also a specimen in the Royal Ontario Museum (26.10.11.114) was found dead in a barn at Port Sydney in 1904.

Inter- and Intra-specific Relationships

The wing chord of the Boreal Owls at Clarkson differed by only 3 mm and suggested that they were probably both females (see Table 1). Initially these owls were 25 yards apart in a dense pine plantation. Although they were both found in the area subsequently, both were not found again on the same day, which suggests the possibility that territories were established.

In three cases a Boreal Owl was found in an area simultaneously occupied by another species of owl. One found in a tall spruce plantation, was only 50 yards from a group of several Long-eared Owls, and in a tree traditionally used by the latter species. In two cases Boreal Owls were found roosting within 100 yards of a Saw-whet Owl.

On one occasion an owl was observed being harassed by a flock of Black-capped Chickadees (*Parus atricapillus*). The birds called continually, often in unison, and flew all around it, but maintained a minimum distance of ca. 1 ft. This gradually subsided after 5 minutes. The owl opened its eyes wide and turned its head quickly following the movements of the first Chickadee to discover it, but soon resumed its normal roosting attitude, which it maintained throughout most of the harassment. Rusk (1962) has also observed Chickadees harassing this species. Blue Jays (*Cyanocitta cristata*) and Downy Woodpeckers (*Dendrocopos pubescens*) were seen harassing a Boreal Owl near Rouge Hill in 1958 (D. H. Speirs, pers. comm.).

Behaviour

During the day Boreal Owls appeared to be inactive, spending hours motionless, with eyes nearly closed. Certain behavioural attitudes induced by disturbance, such as concealing posture, have been described (Catling, 1972).

There are numerous references to the ease with which Boreal Owls are closely approached. Those banded in 1969 were easily captured with a noose and 6 ft pole, and most could have been easily recaptured (after banding) in the same way. In this respect they seemed to show less "fear" than Saw-whet Owls. Once captured, the birds were aggressive, grasping with the talons, bill-clapping, and occasionally even grasping with the bill. Larger owls (probably females) seemed to be more aggressive than smaller ones (probably males).

One owl was observed for an hour after release. It was active and alert for ca. 5 minutes, but then settled quietly. Shortly before dusk it became very active and began vigorously trying to remove the lock-on band with its bill, holding the banded leg up, and balancing on the other.

Food, Feeding Behaviour, and Pellet Analysis

Fisher (1893, p. 159) suggested that the Boreal Owl "feeds largely on small rodents and insects, and when these are scarce depends on small birds for sustenance". Taverner (1922) reported: "Of 9 stomachs examined, 1 contained a small bird; 7, mice; and 4, other mammals." Other general references to the diet of this species are summarized by Earhart and Johnson (1970).

South of their breeding range, in winter, Boreal Owls appear to prey mostly on mice. Wolfe (1923) reports finding the remains of three mice (all *Peromyscus leucopus noveboracensis*) in the stomach of an owl taken in New York State. Mendall (1944, p. 206) reports on 20 specimens collected in Maine and representing all months except June, July, and August: "Fifteen contained sufficient food for tabulation . . . Eleven (73%) contained mice, chiefly meadow voles; three (20%) held short-tailed shrews; one had the remains of a domestic

TABLE 2. — Showing total number, % total prey individuals, and % total weight of all prey, for each species found in ca. 75 pellets of Boreal Owls in southern Ontario during February and March, 1969.

Species	Number (n)	% Total prey individuals	Medium weight (w)[1]	Total weight (w × n)	% Total weight of all prey[2]
Sorex cinereus	2	2.7	4.5	9	0.3
Blarina brevicauda	1	1.4	19.5	19.5	0.6
Condylura cristata	3	4.2	55.5	166.5	5.5
Peromyscus sp.	4	5.6	21.9	86	2.9
Microtus pennsylvanicus	62	86.2	44.0	2728	90.7
Totals	72	≃100		3009	≃100

[1]Median weights are derived from the extremes given by Peterson (1966)
[2]Percentage total weight of all prey suggests the relative importance of prey species.

pigeon; and one contained grasshoppers." Snyder (1947, p. 46) examined fewer than six stomachs and did not illustrate the results. The stomach of a male from Toronto (R.O.M.Z. No. 76665-1955) contained the skull of a short-tailed shrew (*Blarina brevicauda*).

A Boreal Owl found by H. Elliot and the author in January 1966 near Pickering was roosting 7 ft from the ground and 2 ft from an entire meadow mouse (*Microtus pennsylvanicus*) secured in the notch of a branch on the same cedar tree. This owl was left undisturbed, its position having been carefully noted. An hour later the mouse was not there (nor had it dropped from the tree), and the owl had moved to within 2 inches of where it had been secured. Three other entire meadow mice were found similarly fixed in branches of cedar within 10 ft of the ground, not more than 50 yards away. Presumably this was the work of the same Boreal Owl, although Saw-whet and Long-eared Owls were also present in the woods. I am unaware of any other record of Boreal Owls "storing" prey during the winter, or utilizing such a storage (as appeared to be the case here). Mumford and Zusi (1958) relate how a Saw-whet Owl returned to a place from which it had been frightened and retreived a decapitated mouse.

In February 1969, two Boreal Owls were discovered in the early afternoon holding decapitated prey, which in each case was a meadow mouse.

Many more data on food were obtained during the 1968-69 insursion through the analysis of approximately 75 pellets. These represented 18 collections of less than ten each from six localities, separated by at least five miles, probably representing at least six different Boreal Owls. All collections were made from beneath roosting Boreal Owls, and from roosting sites apparently utilized exclusively by this species.

Total number, % of total prey, and % of total weight of prey for each prey species found in these 75 pellets is shown in Table 2. The meadow mouse appears to have been the most important food of Boreal Owls in 1969, representing 86.2% of total prey individuals and 90.7% of the total weight of all prey. The remaining 13.9% of prey individuals (representing only 9.3% of total weight) included star-nosed moles (*Condylura cristata*), white-footed mice (*Peromyscus* sp.), short-tailed shrew, and masked shrews (*Sorex cinereus*); of which the first mentioned were more important. To a limited extent food appeared to be a reflection of habitat. Where an owl had roosted in a one-acre pine plantation surrounded by open farmland (Clairville), *Microtus pennsylvanicus* was the only prey item. Pellets from an owl roosting on the edges of a deep swamp bordered by old fields (Pickering Beach), revealed 12 (70.6%) *Microtus pennsylvanicus*, 2 (11.8%) *Condylura cristata*, 1 (5.9%) *Blarina brevicauda*, 1 *Sorex cinereus*, and 1 *Peromyscus* sp.

Although collections of pellets could be associated with individual owls of known size, food could not be related to size dimorphism.

Pellet Size

Of the total pellets collected, 50 were measurable, the rest being badly mutilated. The average width was 18.2 mm with 82% between 17 and 19 mm incl. The average length was 36.5 mm with 64% between 30 and 40 mm incl.

Pellet Contents

Forty-three pellets (representing 15 collections from various localities) were closely examined. Twenty (46.6%) averaging 33.6 mm long contained ½ of one mouse (*Microtus pennsylvanicus*). Of these, 10 (23.3%) averaging 34.4 mm long were found to contain bones representing the anterior portions as evidenced by a skull, and frequently also the fore-limb bones. Thirteen (30.3%) averaging 41.8 mm long were found to contain one whole mouse (*M. pennsylvanicus*). Of the remainder, four (9.3%) averaging 36.5 mm long contained the incomplete parts of two depredations. Finally, two pellets (4.7%) averaging 27.5 mm long contained fur and a very few vertebrae bones.

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The Evolution of a Discrete Beaver Habitat in the Mackenzie River Delta, Northwest Territories[1]

DON GILL

Department of Geography
University of Alberta
Edmonton, Alberta

Abstract. The *in situ* sequence of physical and biological events that creates a discrete beaver (*Castor canadensis kuhl*) habitat in the Mackenzie River Delta is traced through time. Fluvial and sedimentation processes along a shifting channel create an environment that is conducive to the colonization of a poplar (*Populus balsamifera*) seral community. Depressions formed immediately inland from such sites may be colonized by beavers, after which they are adjacent to a large and preferred food source. Selective use by beavers may locally alter the flora to maintain a zootic climax until the site is abandoned. After abandonment, poplar regeneration may once again attract beavers so that a cyclic pattern of use is established.

Introduction

The classic work of Cowles (1899) on the ecology of Lake Michigan sand dunes was one of the first to adequately link the dynamic interactions between physiographic and biologic features. Other ecologists have since used this approach, but few have sought to correlate the processes of fluvial geomorphology with plant and animal ecology, particularly in a high-latitude environment. This paper thus presents a new approach to northern habitat studies by tracing one *in situ* sequence of physical and biological events that is responsible for the development of a discrete animal habitat in the Mackenzie Delta. The natural world does not function in compartments, either in time or space, thus the seven steps outlined here are somewhat artificial. Such sectioning is valuable, however, in reconstructing this type of environmental time sequence.

[1]This is a modified version of a paper presented at the Annual Meeting of the Canadian Association of Geographers, University of Waterloo, Waterloo, Ontario, May 31, 1971.

Step one — Helicoidal Flow

The prime initiator in the ecologic linkage that ultimately creates a discrete habitat in the Mackenzie River Delta is a common component of fluid dynamics, that of helicoidal flow along a shifting section of channel. In a cross-section through a shifting distributary, the velocity of flow is not symmetrically distributed; maximum current speed is attained by water which flows near the concave bank. Surface water there plunges downward, producing a "cross-channel velocity compenent" (Leopold, 1962) which is directed along the bed toward the convex bank. Bed water then emerges at the surface near the convex bank, causing coarse bed load to be swept laterally toward and up the bank to be deposited. Leopold and Wolman (1960) state that this cross-channel compenent of bed flow is the principal mechanism for the construction of point bars — deposits of lateral accretion that constitute the convex bend of a shifting floodplain channel.

Point bars in the Mackenzie Delta are principally constructed during the annual mid-May to mid-June flood period. Since point bars are built by lateral accretion, their heights are coincident with the average flood stage, some 11-12 feet (3.5 m) above mean summer channel level.

Step two — Sediment Sorting on Point Bars

Helicoidal flow is also responsible for sediment sorting during point bar construction. Since this flow pattern occurs only at shifting channel sections, it follows that downstream from a point bar its influence on sediment deposition becomes progressively diminished. As a result, the proportions of coarse bed-load

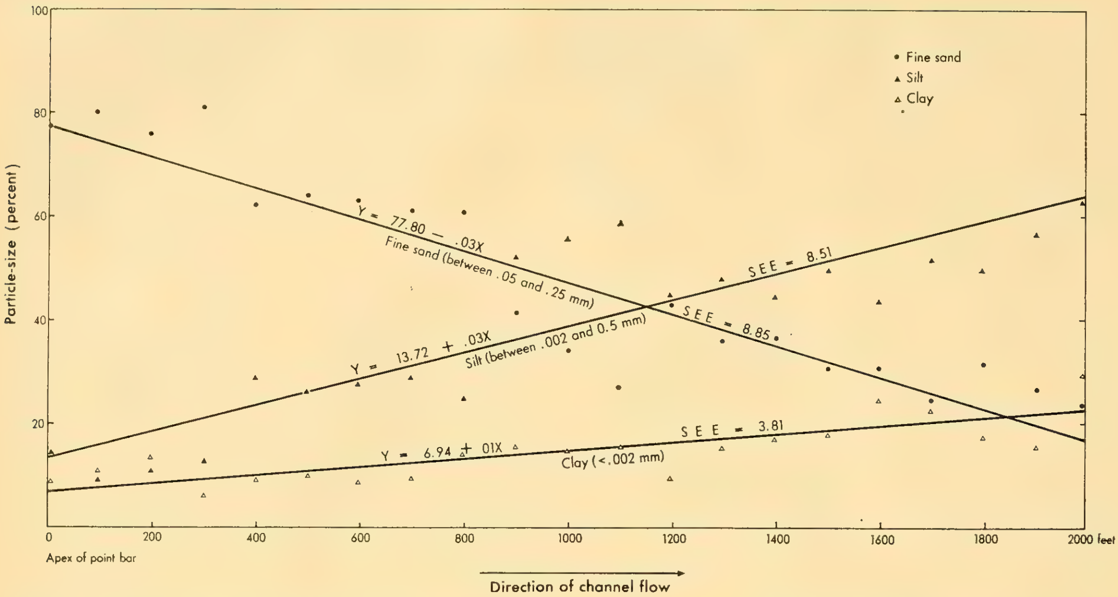

FIGURE 1. Distribution of sediment texture down-channel from a point bar in the Mackenzie Delta.

material should be much greater in point bar alluvium than in sediment deposited farther down-channel. Figure 1 illustrates this well; it is derived from 21 samples of alluvium deposited during the 1967 flood period along the leading edge of a point bar and adjacent (down-channel) slipoff slope in the Mackenzie Delta. Sampling was initiated on the point bar apex and continued downstream at 100-foot (30.5 m) intervals for a total of 2,000 feet (610 m). The Figure shows that material sampled from the apex of the point bar is quite coarse (it has a loamy sand textural classification). The clay and silt fractions increase downstream because the diminishing energy of helicoidal flow can no longer sweep large amounts of sand upward against the slipoff slope thus at the end of the transect the sediment classifies as a silt loam.

This sample plus others taken from a number of similar locations illustrate that point bars in the Mackenzie Delta are composed of nearly uniform deposits which range in size from sandy loam to loamy sand. Point bars thus present the largest accumulations of coarse alluvium in the Delta. Fisk's (1947) investigations in the Mississippi Delta also indicate that point bar deposits contain the coarsest deltaic material.

Step three — Formation of Meander Scroll Depressions

Elongated, arcuate depressions were observed behind nearly all point bars and adjacent (down-channel) slipoff slopes examined in the Mackenzie Delta. The depressions lie between what Davis (1913) originally termed "scrolls" — long, parallel ridges built within a meander loop by the process of point bar formation. In much of the Delta, such depressions are significant in affecting the distribution of vegetation (Figure 2), especially by impounding water to greatly affect biota. They are seldom inundated by spring floods, but nevertheless collect water annually, receiving sufficient runoff from locally melting snow and/or spring rains to become bankfull. Permafrost seals the bottom of these depressions, making drainage impossible, causing them to remain flooded for much of the summer (Figure 2).

If the Mackenzie Delta were not underlain by permafrost, ponding in these depressions

would still most likely occur, since they are sealed by layers of fine clay deposited during floods of sufficient height to overtop the scrolls. Kolb and Van Lopik (1958), when investigating the Mississippi River deltaic plain, also found the floors of meander scroll depressions to be composed of clay deposits. This is probably a universal geomorphic condition of floodplains.

Step four — Vegetation Response to Point Bars

The influence of point bars upon the flora of the Mackenzie Delta results primarily from their coarse composition. Soil formed from such deposits are considered on the basis of soil texture and species presence to be the driest of any plant community in the Mackenzie Delta. Soil moisture measurements verify this classification; for the two summers of study (1966-1967), soil moisture on the upper surface of one point bar averaged 16% (ratio of wet to dry weight). Moisture retentivity tests during 1967 in this location gave an averaged value of 21%, indicating that at no time during the growing season did the soil reach field capacity.

Active layer measurements on this point bar during the 1967 growing season indicated that the thawed layer had reached a depth of 4 inches (10.2 cm) by May 25, and ultimately became 3 feet (0.91 m) deep by the end of summer. Early heat accumulation is due to two reasons: first, upper point bar surfaces normally do not flood, thus soil moisture values are low at this time of year (range of 14 to 18%). Less heat is therefore dissipated in evaporation. Secondly, the point bar community is composed of deciduous species, and leaf periodicity is such that the canopy is not fully developed during early and mid-June, thus thermal admittance is high and the ground warms accordingly.

Between May 25 and September 10, 1967, weekly soil temperatures near the surface (upper 3 inches [7.6 cm.]) averaged from 37° F. (2.8° C.) to 56° F. (13.3° C.) (Figure 3). Individual (point) readings at the soil surface were as high as 78° F. (25.6° C.), indicating that on point bars high soil temperatures for this latitude (69° N) may occur.

It is interesting that weekly soil temperatures measured at a similar depth by Viereck (1970) during 1965-66 in a similar plant community on the floodplain of the Chena River in Central Alaska (65° 20′N) reached maxima only slightly higher than those recorded in the Mackenzie Delta, some 260 miles (416 km) farther north. Furthermore, Central Alaska has a more continental climate than the Mackenzie Delta, thus relatively higher summer temperatures are experienced. The July mean for Fair-

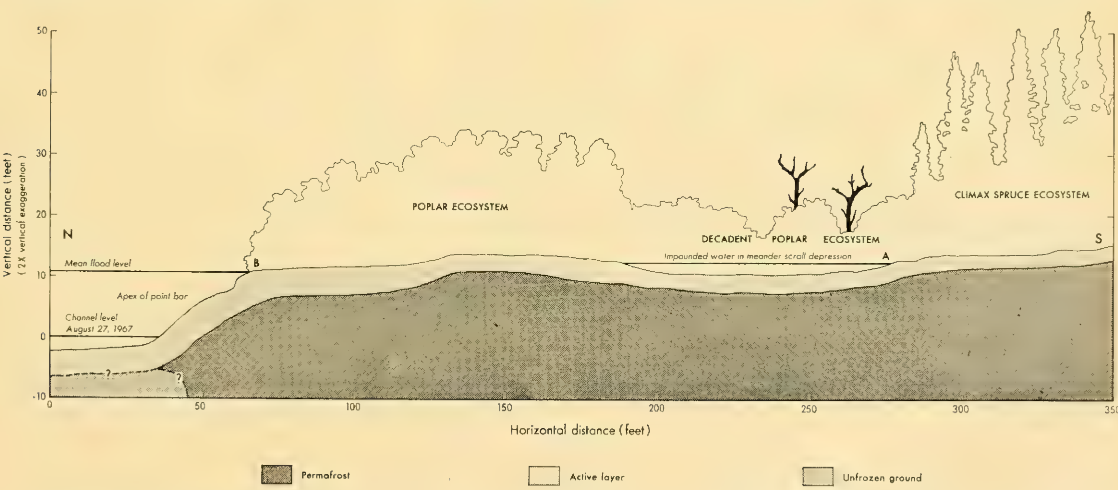

FIGURE 2. Common position of poplar ecosystem and meander scroll depression along a point bar traverse in the Mackenzie Delta.

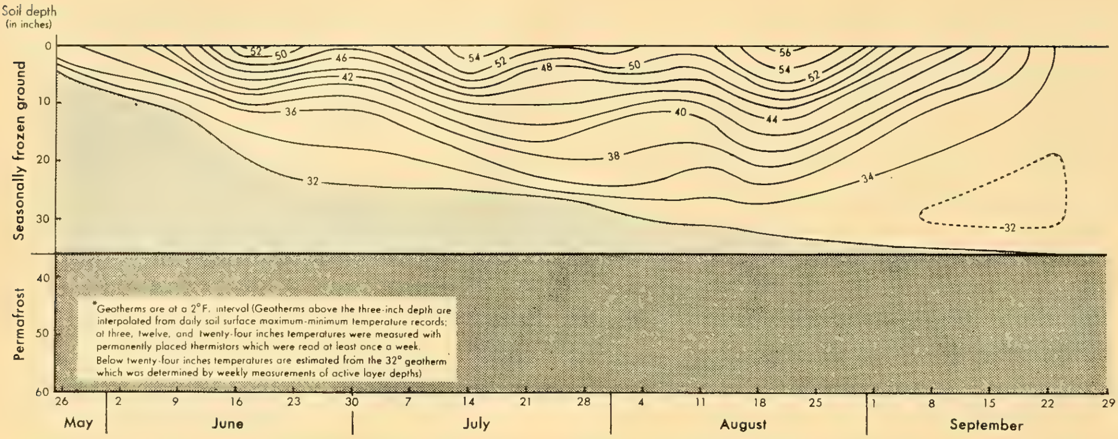

FIGURE 3. Geotherms* indicating mean weekly soil temperature fluctuations in a poplar community during the 1967 summer period.

banks is 60° F. (15.5° C.) (Viereck, 1970) while Tununuk, in the northeastern Mackenzie Delta, has a July mean of 53.5° F. (12° C.) (Abrahamsson, 1966). The two communities studied are similar in age, but tree height and density, and understory species composition are dissimilar, which at least partially accounts for the differences in soil temperature. Furthermore, temperatures were measured over separate summer periods, which may account for dissimilarities. Perhaps as important, however, the substrate of the Chena River site contains layers of moist silt, and is not sorted as uniformly as the sandy substrate of the Mackenzie Delta stand. Soil moisture thus averages some 9% higher in the Chena River stand, which could individually account for the differences in soil temperature.

The entire surface of the Mackenzie Delta is covered by recent alluvial deposits, thus individual plant habitats are created largely by differences in flooding and sediment processes. Vegetation response to the relatively warm and mesic soil conditions created by the mechanics of point bar construction has been such that the prograding edge of virtually every point bar is colonized by a discrete successional community dominated by the balsam poplar (Figure 4). On many point bars this community functions as the pioneer stage (Figure 2). Even in permafrost areas the balsam poplar is a comparatively deep-rooted species, and it requires a soil which is relatively warm (Stoeckler, 1952). Balsam poplar also requires good soil aeration for the proper respiratory functioning of its roots, thus it benefits if there is a high proportion of sand in the sedimentary soil. These requirements are best met on point bars, which offer a distinct phenological and microclimatic advantage to plant colonization.

Step five — Vegetation Response to Meander Scroll Depressions

Immediately behind most point bar poplar communities are meander scroll depressions. In the process of colonizing the upper point bar surface, poplar often extends down the front of the levee toward the channel (note the distribution of poplar at location B, Figure 2). Channel shifting in the Mackenzie Delta has occurred at an irregular pace (due to different intensities of annual flooding, localized damming by ice jams, etc.) which has resulted in uneven levee and point bar construction. Thus if poplar trees extend down the face of a point bar, their eventual site will be a poorly drained depression if accelerated deposition constructs another meander scroll in front of it. Location A, Figure 2, illustrates an earlier point bar face; a climax white spruce (*Picea glauca*) community has succeeded the previous poplar sere at this location, while impounded water

in the meander scroll depression has caused the death of the remaining poplar (also see Figure 4), and enabled moisture-tolerant willow species (especially *Salix alaxensis, S. arbusculoides,* and *S. richardsonii*) and alder (*Alnus crispa*) to succeed.

Step six — Animal Response to the Point Bar-Meander Scroll Depression Complex

The northernmost distribution of beaver in North America occurs in the Mackenzie Delta. Hawley (1968) estimated that in 1966 and 1967 (the duration of the present study) between 1,600 and 2,000 colonies of beaver occupied a relatively uniform habitat of 4,000 miles^2 (6,400 km^2) within the Delta. As shown by Aleksiuk (1968) the northerly location (67° 30′ - 69°N) has created a harsh bioclimate for this animal. An additional constraint is the great volume of flow (especially during the flood stage) through the Delta's distributaries which makes it virtually impossible for beavers to construct normal dams and lodges. As a result, most of the Delta's beaver population utilizes bank dens. However, when a pair of beavers come in contact with the natural impoundment of a meander scroll depression they may react to the shallow reservoir and the adjacent supply of poplar by damming the lower rim of the swale to impound additional runoff (Figure 5). After the water reaches a sufficient depth, a lodge may be built and a colony established. The author located 11 such colonies in meander scroll depressions in the Mackenzie Delta.

FIGURE 4. Low-oblique air-photo showing a poplar community occupying the apex of a point bar. The poplar stand can be differentiated by its somewhat lighter tone; photograph was taken in late August 1967, after poplar but before willow leaves had begun to turn color. To the right of the stand is a meander scroll depression (shown by arrow), occupied by dead poplar trees. Direction of channel flow is toward the camera.

FIGURE 5. A new beaver dam impounding water in a meander scroll depression in the Mackenzie Delta. Note drowned poplar stems cut by beaver.

Step seven — Utilization of the Adjacent Poplar Community by Beavers

The dammed meander scroll depression contains some usable vegetation in the form of willow and alder. The poplar community immediately adjacent to the swale provides the beavers' greatest food source, however. After beavers occupy such locations for a number of years, the stands show much evidence of selective use; along the swale periphery, most of the poplar trees are felled (Figure 5), and secondary succession of less palatable alder and willow species occur. Aquatic succession within the impounded swale further alters the previous flora.

Beavers normally then abandon the site, after which rapid clonal regeneration of poplar takes place. When the saplings reach sufficient maturity, the point bar may again attract beavers. This type of cyclic use was seen on a number of point bars as evidenced by a present beaver colony as well as very old beaver-cut stems.

Summary and Conclusion

The sequence of physical and biological events that create a distinct type of beaver habitat in the Mackenzie River Delta was traced. Helicoidal flow during channel shifting initiates sediment sorting and deposition of coarse alluvium on point bars; meander scroll depressions that impound local runoff are also formed during this process. Plant succession on coarse point bar deposits is such that species preferred as food by beavers colonize there. Beavers are thus attracted to point bars after which they may dam the adjacent scroll depressions and construct lodges near their food source. Selective use by beavers alters the flora of point bars, causing secondary succession to occur. If the site is occupied for a sufficient length of time, a zootic climax is established whereby alder and willow species become dominant. Beavers then abandon such point bars, permitting poplar to regenerate. A cyclic pattern of use may thus be established.

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Spinulose Wood Ferns *Dryopteris*, in Western North America

Donald M. Britton

Department of Botany and Genetics, University of Guelph, Guelph, Ontario

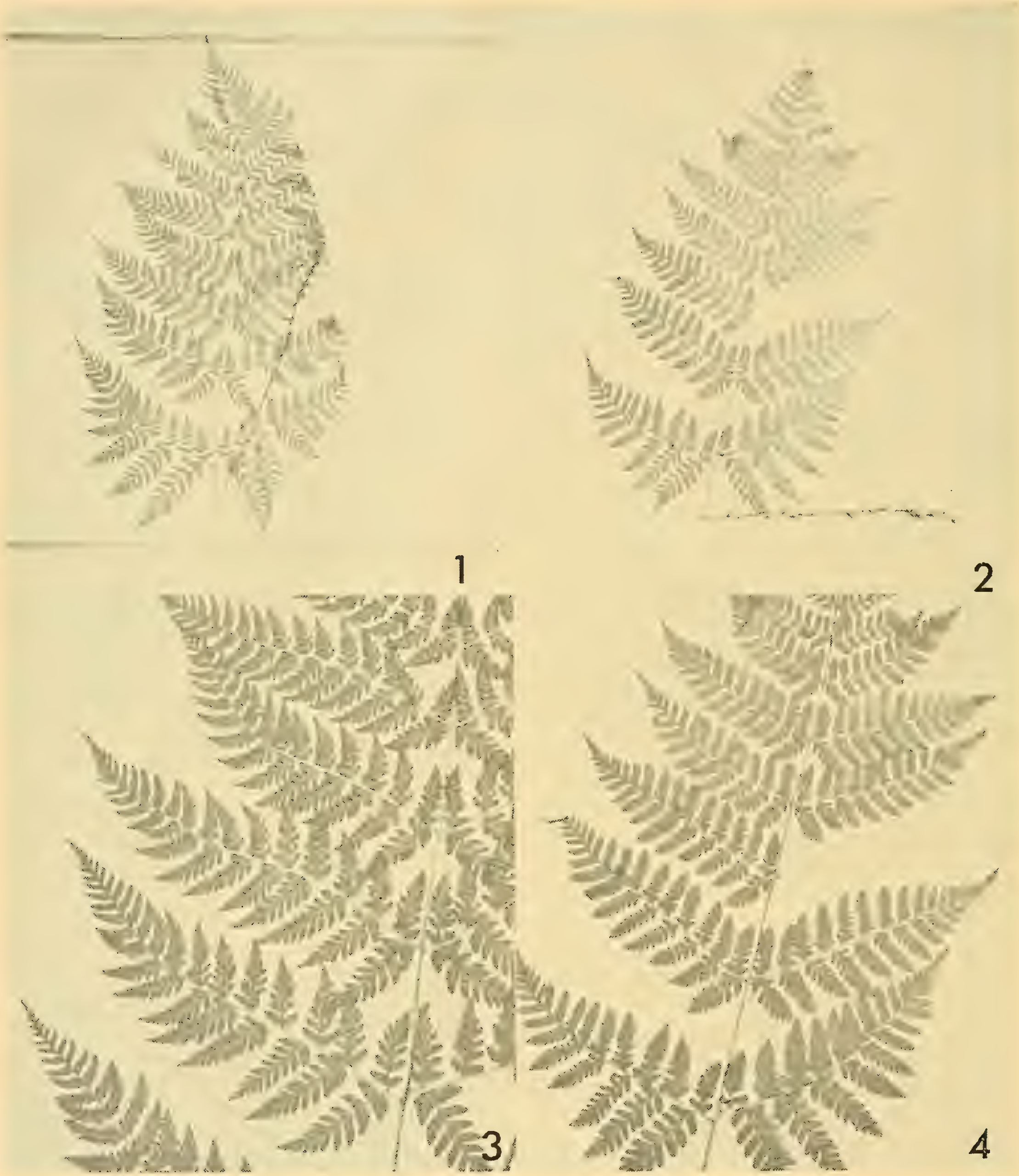
Abstract. The distribution of the tetraploid taxon, *Dryopteris spinulosa* (O. F. Mull.) Watt (*Dryopteris carthusiana* (Villars) H. P. Fuchs) in western North America is delineated. The common and abundant diploid taoxn in the West is considered to be *Dryopteris assimilis* S. Walker, not *Dryopteris austriaca* (Jacq.) Woynar which is a tetraploid taxon of Europe. *Dryopteris intermedia* (Muhl.) A. Gray, although reported as being present in Montana and Idaho is not proven to be present.

The large, handsome and characteristic *Dryopteris* species found in the Lake Superior Basin (Britton and Soper 1966) is a diploid taxon ($n = 41$) and greatly resembles the tetraploid taxon found in the Appalachians (*Dryopteris campyloptera* Clarkson). The diploid taxon is not confined to the Lake Superior watershed however, as it is known from Amos, Eastmain and Paint Hills in northwestern Quebec (Britton 1967) and as far east as Métis Beach and Mount Albert in the Gaspé (Widén and Britton 1971) where it is apparently rare. A diploid segregate species from tetraploid *Dryopteris dilatata* s. str. has been recognized in Europe as *Dryopteris assimilis* S. Walker (Walker and Jermy 1964). The question arises as to whether the eastern diploid in North America is conspecific with *Dryopteris assimilis.* Also, what is the relationship of the two taxa in eastern North America with the diploid in western North America variously referred to as *Dryopteris austriaca* (Jacq.) Woynar, *Dryopteris dilatata* (Hoffm.) A. Gray etc. (see synonymy in Hitchcock et al. 1969)? Further questions concern the distributions of the various taxa. What is the distribution of the western taxon? What are the distributions in the West of the predominantly eastern species. *Dryopteris spinulosa* Watt [(*Dryopteris carthusiana* (Villars) H. P. Fuchs (4×)], and *Dryopteris intermedia* (Muhl.) A Gray (2×)?

In 1969, the author collected in Idaho and Montana with the purpose of studying cytologically and comparing morphologically these western diploid plants with plants from the most westerly stations of the eastern diploid. Idaho and Montana were chosen because of the large number of species of *Dryopteris* reported from the former by Flowers (1950) and suggestions that *Dryopteris intermedia* was present in Montana (Davis 1952, Frye 1934). Also, it was hoped that hybrids might be found in the West for cytological studies, and that the distribution of *Dryopteris spinulosa* and *Dryopteris intermedia* might be clarified. In preparation for the trip, local and state floras were studied and specimens were borrowed from ID, IDS, MONTU, WSP, UBC and others were studied at QUK, TRT and GH.

Collections of *Dryopteris* were made from near Lolo Pass, Idaho; beside Devoto Memorial Grove, Idaho; Glacier National Park, Montana and Waterton Lakes Park, Alberta. These are cited in full in Widén and Britton (1971). Thirteen specimens (Figure 1) had a normal, regular meiosis and were diploid ($n = 41$). Following Hitchcock et al. (1969) they were referable to *Dryopteris austriaca. Dryopteris spinulosa* (Figure 5) was found to be abundant at both John's Lake and at the eastern end of Lake McDonald, Glacier National Park. Eight specimens were studied cytologically and all had a normal meiosis with $n = 82$. At the head of Lake McDonald large numbers of both the western diploid and of *Dryopteris spinulosa* occurred intermixed, and the locality looked like an excellent one for hybrids, however none were discovered.

Although *Dryopteris cristata* was collected at John's Lake as evidenced by *Paul C. Standley*



FIGURES 1 and 3. *Dryopteris assimilis* S. Walker, *Britton 1686*, from Montana, Glacier National Park, Lake McDonald, June 26, 1969.

FIGURES 2 and 4. *Dryopteris assimilis* S. Walker, *Britton 805*, Ontario, Thunder Bay District, Jackfish Lake, June 27, 1964.

FIGURE 5. *Dryopteris spinulosa* Watt, *Britton 1714,* Montana, Glacier National Park, June 27, 1969.

FIGURE 6. *Dryopteris intermedia* Gray, *Britton 582,* Ontario, Grey Co., Skinner's Bluff, June 15, 1962.

18527 (GH) (Standley 1921), this species was not seen.

No collections were made of *Dryopteris intermedia* in Idaho and Montana. Circumstantial evidence of its absence at John's Lake and Lake McDonald was indicated in that no *Dryopteris intermedia* × *spinulosa* (*Dryopteris* × *triploidea* Wherry) were present in, or near the large colonies of *Dryopteris spinulosa.* This would be an unlikely absence in eastern North America.

Accordingly, the most easterly members of the western diploid taxon which we have are those reported from Rocky Mountain National Park, Colorado; Lake McDonald, Glacier National Park; and Waterton Lakes, Alberta. In western Alberta, this taxon is only occasionally found east of, or immediately on the Continental Divide, e.g. Waterton Lakes, Mount Edith Cavell, Lake Louise, Alberta, in areas where it is cool and moist. Northward, the distribution of the species is now fairly clear. Cody and Porsild (1968) cite a number of specimens from the Yukon and one in Mackenzie close to the Yukon border, which is the most easterly record in the area (Flat River 61° 58′N., 128° 15′W.). A plant from this last locality in western Mackenzie was studied cytologically by Mulligan & Cody (1968), and was found to be diploid. Scamman (1949) says the most northerly record in the Yukon Valley is from Circle Hot Springs and Hultén (1941) says it is apparently absent in the upper Yukon Valley. The distribution of the western diploid is northern California, Oregon, Colorado, Washington, Idaho, Montana, Alberta, British Columbia, the southern Yukon, western Mackenzie and Alaska. A good, recent distribution map for the species is given by Taylor (1970). Although I agree with the concept of Hultén (1958) of the broad range he has shown for *"Dryopteris dilatata"* (Map 156), I cannot agree with the

broad swath of occurrence he has shown across Manitoba, Saskatchewan and Alberta.

Cytological studies by Walker (1961) and chromatographic work by Widén (Widén and Britton 1971) both suggest that this taxon is conspecific with *Dryopteris assimilis* S. Walker of Europe. Weber (1967) has already taken up this name for the taxon in Colorado.

The most westerly record for the eastern diploid taxon (Figure 2) is from French Lake, Quetico Provincial Park (Widén and Britton 1971). This is just outside the Lake Superior Basin and is only slightly west of the localities plotted by Lakela (1965). Fewer than ten plants were seen scattered with the more abundant *Dryopteris spinulosa* and *Dryopteris intermedia* (Figure 6).

Critical evidence for naming this taxon is still lacking. No artificial hybridization experiments have been done and the chromatographic evidence is inconclusive (Widén and Britton 1971). Nevertheless, its affinities certainly lie with *Dryopteris assimilis* of Europe, Iceland and Greenland. For the present, it is proposed to call it *Dryopteris assimilis*. This path avoids using the name *Dryopteris dilatata* which is tetraploid in Europe, and which may properly be referred to as *Dryopteris austriaca* (Jacq.) Woynar (Jermy 1969). There is no evidence for the presence of this latter taxon in North America, unless one refers to the whole complex by this name (e.g. Boivin 1966). It would seem a mistake to use the name of a tetraploid taxon common and well known in Europe but apparently absent in North America. The situation has a parallel with *Polypodium vulgare* (Perring and Sell 1968) and it would be possible to effect a similar solution. However, relegating basic diploid entities to the rank of subspecies has little appeal to cytotaxonomists.

The report of *Dryopteris intermedia* in Montana stems from the publication by Graff (1920) in which he cites a specimen collected by M. E. Jones from Lake McDonald, Glacier National Park, August 25, 1909 at 950 meters. I thought that this specimen was missing at MONTU until I noticed in an article by Fitzpatrick (1904) that Lake McDonald had sometimes been called Lake Terry in the early 1900's. For purposes of publication, Graff apparently updated the locality data on the label from Lake Terry to Glacier National Park, Lake McDonald and transformed the 3,000 feet to 950 meters. However, this specimen is glabrous and has the characteristics of typical *Dryopteris spinulosa* (MONTU No. 0090). It shows no indication of the semi-evergreen (dark bluish-green) character of *Dryopteris intermedia*. As stated previously, the absence of *Dryopteris* × *triploideaa* at Lake McDonald would also suggest the absence of *Dryopteris intermedia*.

Reports of *Dryopteris intermedia* in Idaho are more prevalent. Flowers (1950) cites two specimens. The second is from Lowell [*Shattuck and Fenn*, June 25, 1910 (ID)]. This is a small, badly broken specimen. However, the one basal pinna present, suggests western *Dryopteris assimilis* in its shape and length of the basal innermost pinnule. It does not have the dissection of *Dryopteris intermedia* and it looks as if it was collected from a dry site. The specimen matches *R. Daubenmire 59188* (WSP) originally identified as *Dryopteris spinulosa*, but the blade is too short and broad for that species. Also, the basal pinnae have the typical deltoid appearance of *Dryopteris assimilis* and there is good separation between the upper and lower pinnules next to the rachis. The specimen also matches *Britton 1292*, a diploid from Mount Albert, Gaspé. Another specimen identified as *Dryopteris intermedia*, *J. H. Sandberg et al. No. 874*, August 8, 1892 from US at QUK, has short inferior pinnules next to the rachis, but it is glabrous and the blade dissection and aspect suggest that it is *Dryopteris assimilis*.

The specimen from City Creek, Pocatello, collected by R. J. Davis, June 1931 (IDS) is an interesting one. It has a note from C. A. Weatherby dated January 1937 which says that he knows of the Glacier National Park specimen but that he has not seen it, and that the variety is "not known west of Missouri". There is also a note from Davis, "I collected this in quantity for class use from one big clump, but I have never been able to find any more of it. 1945." The specimen certainly has the general

aspect of *Dryopteris intermedia.* In particular, it has a dark bluish-green color which suggests the sub-evergreen character of *Dryopteris intermedia.* It is glandular, and the individual pinnules have the dissection of *intermedia.* Against this view, is the shape of the pinnae. These are widest at their base (overly so), and the pinnae are more overlapping than in *Dryopteris intermedia.* The specimen is broader than all but extremes of this taxon. In overall aspect it appears "heavy" rather than lacy. Unfortunately, the basal pinnae appear to be missing, or possibly more than the basal pinnae. The specimen is definitely not close to *Dryopteris spinulosa,* but seems to fall between the extremes of *Dryopteris assimilis* and *Dryopteris intermedia.* Of the western *Dryopteris assimilis* I have seen, it is closest to one from the Olympic Mountains, Washington, June 20, 1902, *John M. Grant 217* (GH), which is also glandular. To accept this record as *Dryopteris intermedia,* it should be re-collected and compared with possible variations of western *Dryopteris assimilis.* To accept it as a disjunct record, one would have to ask why it is absent in Colorado, Wyoming and Montana in suitable habitats? Also, having been used for class material, there is the possibility that it became mixed with material from an easterly locality. Until further specimens come to light, the distribution of *Dryopteris* intermedia in the West, seems to rest on this one dubious specimen from near Pocatello.

Typical *Dryopteris spinulosa* is scattered in the West. In Mackenzie District, the most northerly and westerly specimen appears to be *Bedford s.n.* (CAN) between Great Slave Lake and Great Bear Lake as cited by Raup (1947). Hultén (1941) states that it appears to be absent in Alaska and the Yukon. Some representative western collections of typical *Dryopteris spinulosa* Watt are cited below:

ALBERTA: Lesser Slave Lake, *E. H. Moss 2236, 2678,* Widewater, Lesser Slave Lake, *E. H. Moss 6080* (GH), Elk Island Park, 20 miles east of Fort Saskatchewan, *Turner 3133* (GH), Chipewyan, *Hugh M. Raup and Ernst C. Abbe 4689* (GH).

BRITISH COLUMBIA: Alaska Highway, Mile 496, *A. E. Porsild 9035* (GH), Vicinity of hot spring near lower crossing of Liard R., *Hugh M. Raup and D. S. Correll 11541* (UBC), Kootenay Lake, *M. Bell s.n.,* 27 July 1958 (UBC).

IDAHO: Bonner County: Section 10T60NR 5W, *R. F. Daubenmire s.n.* August 16, 1966 (WSP). Idaho County: Southeast of Harpster, *R. F. Daubenmire 47134* (WSP). Kootenai County: Granite Station, *J. H. Sandberg et al. 799* (GH).

MONTANA: Flathead Lake and Vicinity, Swan Lake, *Mrs. Joseph Clemens s.n.* (GH) John's Lake, near Lake McDonald, *Susan B. McKelvey s.n.* (GH). Lake Terry, 3,000′ altitude, August 25, 1909, *Marcus E. Jones, A.M. s.n.* (MONTU).

Flowers (1950) cites a specimen from Little North Fork, Clearwater River in Idaho, *Picket 133* (WSP). This is a large specimen with a well dissected blade. The basal pinnae are deltoid with a good separation of innermost pinnules. Scales are present at the base of the pinnae. It is *Dryopteris assimilis* S. Walker. Others which are referable to *Dryopteris assimilis,* rather than *Dryopteris spinulosa,* are *J. H. Christ 10943,* Benewah County, Washington (IDS), *R. Daubenmire 5544,* Granite Creek, Pend Oreille County, Washington (WSP), *R. Daubenmire 5543,* Granite Creek, Bonner County, Idaho (WSP), *R. Daubenmire 59188,* 6 miles southwest of Magee River, Shoshone County, Idaho (WSP).

A specimen from Headquarters, Clearwater County, Idaho is of interest because it was collected and identified by E. T. Wherry 7-14-40 (IDS) as *Dryopteris spinulosa.* It was annotated as *Dryopteris cristata* by *R. J. Davis,* 7-12-43, and is the only collection of *Dryopteris cristata* for Idaho cited by Flowers (1950). It exactly matches one of my specimens, *Britton 65* (OAC) of the hybrid (*Dryopteris cristata* × *spinulosa*) from Ontario. The parent species are both known from northern Idaho. *Dryopteris spinulosa* specimens are cited above and *Dryopteris cristata* is known from Granite Station, Kootenai County, *J. H. Sandberg et al. 795* (GH).

No consistent differences are apparent when comparing my collections of *Dryopteris assimilis* from Idaho and Montana with those from the Lake Superior Basin. Wagner and Hagenah (1962) state that "western dilatata" has petiole scales which are longer and narrower and with

a more filiform tip, and a more conspicuous black median stripe than those of the Lake Superior plant. Some of my specimens show the conspicuous median stripe (e.g. 1658, 1683) while others do not (e.g. 1684-1686). Also, some have filiform tips while others do not. An examination of 60 specimens from UBC showed only 18 with marked central stripes on the scales. However, Taylor and Calder (1968) state that of 19 collections from the Queen Charlotte Islands, 13 had dark centered scales, whereas six were essentially concolorous. Scamman (1949) has remarked that the specimens collected from the Yukon and Alaska had monochrome scales. Also, Crabbe et al. (1970) indicate that the presence or absence of a stripe on the scales is variable for *Dryopteris assimilis* in Britain — "scales concolorous, pale or red-brown, or with darker median stripe, some ballooned scales on stipe." The presence of dark median stripes on the scales is more typical of the European tetraploid *Dryopteris austriaca* (*Dryopteris dilatata* s. str.). Wagner and Hagenah (1962) consider that the petiole to midrib ratio of the western taxon (70% range 60-94) is more like *Dryopteris campyloptera* than the Lake Superior plants. My western specimens have a stipe to lamina ratio of 1:1.4 (Range 1:1.0 to 1.8). The figures given by Crabbe et al. (1970) for British material are 1:1 to 2:3. The average for 40 specimens from UBC was 1:1.3 and the range from 1:.8 to 1:1.8. The average for 40 cytological vouchers of the Lake Superior plants collected by the author from the Pigeon River on the West to Agawa Bay on the East was also 1:1.3 and the range 1:.8 to 1:1.9. All these results seem consistent for this variable character.

The frond shape of western *Dryopteris assimilis*, judging by herbarium specimens, often equals that of *Dryopteris spinulosa*, so much so, that if the basal pinnae are not well developed, workers have had difficulty in deciding if the specimen was *Dryopteris spinulosa* or not, e.g. Coast Mountains, Oregon, *L. F. Henderson s.n.* 1882, Olymic Mountains, Washington *John M. Grant 217*, Quiniault, Washington, *Henry S. Conard 113* (GH). These long narrow profiles are matched by many specimens from Lake Superior.

When one looks at a large number of specimens of *D. assimilis* from western North America one is struck by the intra-taxon variability. This variability is as great as that between western and eastern *Dryopteris assimilis* as represented by my collections. However, some western *Dryopteris assimilis* have more extreme "laciness" than is seen in the east, e.g. Washington County, Oregon, *J. W. Thompson 4280*, and Nanaimo, British Columbia, *John Macoun 84105* (GH), so much so, that Standley (1920), among others, has remarked on the striking similarity at a distance of this taxon with *Athyrium filix-femina*. If one examines the superior pinnules on each of the pinnae starting next to the rachis, these are broader at their base and taper gradually to a fine tip (Figure 3), whereas the specimens from the east tend to be more uniform in width and terminate in a more acuminate tip (Figure 4). Attempts to statistically quantify this observation were unsuccessful. These same pinnules may have a marked curve in their axis towards the pinnae tips which has not been seen in the eastern taxon. In genetic terms, it is considered that the western population is more variable with a larger gene pool than is the eastern taxon.

Dryopteris assimilis S. Walker is a variable taxon quite responsive in morphology to available moisture, but evidence is accumulating (Hultén 1958, Widén and Britton 1971) that it is a species of cool and moist climate which is circumpolar in its distribution. *Dryopteris spinulosa* Watt is rare and local in the West, and *Dryopteris intermedia* Gray has not been proven to be present west of Ontario and Minnesota.

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Lichens from the Kluane Game Sanctuary, S.W. Yukon Territory[1]

MANFRED HOEFS[2] and JOHN W. THOMSON[3]

[2]Department of Zoology, University of British Columbia
[3]Department of Botany, University of Wisconsin

Introduction

A lichen collection was made during the summers of 1969, 1970 and 1971, while the senior author was involved in a Dall sheep range study in the Kluane Game Sanctuary, S.W. Yukon Territory. The study centered around the Sheep Mt. - Mt. Wallace complex, and most collections were made in this thirty square mile area. An additional collection was made in the Donjek River - Lynx Creek - Koidern River region, while assisting in I.B.P. investigations during the summer of 1971. The enclosed map shows the collection sites.

The natural history of the Kluane area has been described by Porsild (1966), Johnson and Raup (1964) and Drury (1953); the geology, glaciology and climate by Bushnell & Ragle, eds. (1970, 1969), Muller (1967), Krinsley (1965) and Bostock (1952). Only a brief description of the area is given here, which will help to interpret the annotated list of species.

The Kluane Reserve is mountainous. It is composed of four physiographic subdivisions: St. Elias range, Duke depression, Kluane range and Shakwak valley (Bostock, 1948). Lichen collections were restricted to the latter two subdivisions. The Shakwak valley is at an elevation of 2300′ to 2600′. For the most part it is covered by white spruce, which extends up the slopes to an elevation of 3800′ to 4200′. The following sub-alpine shrub zone, composed mainly of dwarf birch and willows, may go as high as 5000′. The alpine zone, which is the most extensive vegetation type in the area, is dominated by mountain avens (*Dryas integrifolia, Dryas octopetala*) and several prostrate willows (*Salix arctica, Salix reticulata, Salix polaris*). The upper limit of vascular vegetation is between 7000′ and 7600′. Permanent snow is encountered at the 8000′ to 9000′ level.

The Kluane Game Sanctuary lies in the rain shadow of the St. Elias Mountains, the climate is semi-arid and continental. Annual precipitation in the Kluane Lake area has been less than ten inches the past few years. Summer temperatures hardly ever approach 80°F, and during winter temperatures of −50°F to −60°F are not uncommon.

The two principal collection sites are very different ecologically. The Sheep Mt. area is very dry and alkaline. Frequent winds, blowing down the Slims River valley from the ice-fields, have deposited a thick layer of loess at the lower elevations of the mountain. A large southeast-facing slope is occupied primarily by grassland vegetation. The presence of the large and deep Kluane Lake has a moderating effect on the local temperatures during the early part of the winter. The Donjek River area is moister and the substrate more acidic. The average precipitation for an eight year period at Snag, an abandoned weather station some fifty miles northwest of collection site two, was 16.2 inches. Black spruce, Sphagnum moss, ericaceous shrub communities, dominated by *Ledum palustre* and *Rhododendron lapponicum,* are found here, but have not been observed in the Kluane Lake area. Temperatures are more severe, particularly in the early part of the winter. Snag holds the record minimum temperature with −81°F.

Annotated List of Species

The lichen flora of the Yukon is incompletely known. Collections made prior to 1967 have been catalogued by Bird (1967). Several important lichen collections have been made

[1]Part of this area is now included in "Kluane National Park".

subsequently, but have so far not been published (J. Thomson, University of Wisconsin; T. Ahti, University of Helsinki; J. Lambert, Carleton University). The present collection adds a considerable number of species to Bird's (1967) list, particularly of the crustose types, associated with grassland vegetation. Many of these have been described for prairie associations in Saskatchewan and neighboring areas by Looman (1964a, b).

The following list gives the species, collection number and locality, as well as some notes on habitat. The statement "New for Yukon" refers to Bird's (1967) catalogue. Several of the species not reported for the Yukon have been collected in Mt. McKinley Park, Alaska, by Weber and Viereck (1967).

All lichens have been identified by J. W. Thomson, and a complete set has been deposited at the University of Wisconsin Herbarium.

Acarospora oxytona (Ach.) Mass.; (43/71); Mt. Wallace; 6600′; exposed, dry site; S.E. slope; growing on igneous rocks. New for Yukon.

Alectoria ochroleuca (Hoffm.) Mass.; (20/71); Sheep Mt.; 6000′; open, dry site; limestone outcropping.

Buellia epigaea (Hoffm.) Tuck.; (4/69, 1/70); Sheep Mt.; 3000′; dry, open, south-facing slope; growing on silt deposits. New for Yukon.

Buellia stellulata (Tayl. in Mack) Mudd; (14/70); Sheep Mt.; 3000′; dry, exposed site; growing on metamorphic rocks. New for Yukon.

Caloplaca cirrochroa (Ach.) Th. Fr.; (4/70); Sheep Mt.; 2800′; dry, open, south-facing slope; growing on silt deposits. New for Yukon.

Cetraria hepatizon (Ach.) Vain.; (48/71); Mt. Wallace; 7700′; moist, alpine plateau; growing on igneous rocks. New for Yukon.

Cetraria nivalis (L.) Ach.; (7/69, 5/71); Christmas Bay at Kluane Lake and Donjek River area; 2700′ and 3500′; open, fairly dry, white spruce forest; silty substrate.

Cetraria islandica (L). Ach.; (21/71); Sheep Mt.; 6000′; moist, alpine slope; shaded by *Salix arctica*; substrate rich in organic matter.

Cetraria cucullata (Bell) Ach.; (5/69, 12/71); Sheep Mt., 5100′; moist, southeast-facing slope; organic substrate. Donjek River-Lynx Creek area; 3500′; moist, shady spruce forest; substrate rich in organic matter.

Cetraria richardsonii Hook.; (2/71); Sheep Mt.; 6000′; moist, alpine meadow; organic substrate.
Cetraria tilesii Ach.; (1/69, 11/70, 26/71, 31/71); Sheep Mt.; most commonly found on moist, alpine east- and north-facing slopes, 5500′ to 6500′; but also collected at 2700′, from south-facing, dry ridge on silt substrate.
Cladonia gonecha (Ach.) Asah.; (11/71); Donjek River-Lynx Creek area; 3600′; moist, shady spruce forest; growing on decaying wood. New for Yukon.
Cladonia lepidota Nyl.; (8/69); Congdon Creek; 3000′; moist, shady spruce forest; substrate rich in organic matter. New for Yukon.
Cladonia gracilis (L.) Willd. var. *dilatata* (Huds.) Vain.; (10/71); Donjek River-Lynx Creek area, 3500′; moist, shady spruce forest; growing on decaying wood. New for Yukon.
Cladonia sylvatica (L). Hoffm.; (6/71); Donjek River area; 4000′; moist, shady spruce forest; substrate rich in organic matter.
Cladonia amaurocraea (Flörke) Schaer.; (7/71); Donjek River-Lynx Creek area; 4000′; moist, shady spruce forest; growing on decaying wood.
Cladonia pocillum (Ach.) O. Rich.; (34/71); Sheep Mt.-Mt. Wallace; 5400′; moist, alpine meadow; organic substrate. (B33/69); Donjek River area; 2800′; moist, shady spruce muskeg; organic substrate. New for Yukon.
Collema coccophorum Tuck.; (51/71); Sheep Mt.; 3000′; open, dry, south-facing slope; silty substrate. New for Yukon.
Cornicularia aculeata (Schreb.) Ach.; (16/71); Sheep Mt.; 6000′; mesic, alpine slope; substrate rich in organic matter. New for Yukon.
Dactylina ramulosa (Hook.) Tuck.; (17/71); Sheep Mt.; 6000′; dry, alpine ridge; growing on thin silt layer over limestone outcropping. New for Yukon.
Dactylina arctica (Hook.) Nyl.; (3/69, 24/70 both P+ strain, 8/71, 19/71 both P— strain); Sheep Mt.; most commonly found on moist, alpine north- and east-facing slopes (5500-6500′), but also collected at 3500′ in moist, shady spruce forest in Donjek River area. Substrate rich in organic matter.
Dactylina madreporiformis (Wulf.) Tuck.; (12a/70, 18/71); Sheep Mt.; 6000′; fairly dry limestone ridge; growing in cracks of limestone. New for Yukon.
Dermatocarpon hepaticum (Ach.) Th. Fr. (7/70); Sheep Mt.; 2800′; dry, open, south-facing slope; very common lichen covering silt (loess) deposits at low altitudes. New for Yukon.
Evernia divaricata (L.) Ach.; (3/71); Donjek River-Lynx Creek area; 3000′; moist, shady spruce forest; arboreal, on dead spruce branches. New for Yukon.
Evernia esorediosa (Müll. Arg.) DuRietz; (23/71); island in Kluane Lake; 2600′; open, dry spruce forest; silt substrate. New for Yukon.
Fulgensia bracteata (Hoffm.) Räs.; (3/70); Sheep Mt.; 3000′; metamorphic rock outcropping; growing in partially shaded, silt-filled cracks. New for Yukon.
Lecanora candida (Anzi) Nyl.; (46/71); Mt. Wallace; 7600′; dry site; growing on igneous rocks. New for Yukon.
Lecanora caesiocinerea Nyl.; (17/70); Sheep Mt.; 3000′; dry west side of metamorphic rock outcropping; growing on rocks. New for Yukon.
Lecanora epibryon (Ach.) Ach.; (29/71, 36/71, 39/71); Sheep Mt.-Mt. Wallace; 6000′-7700′; moist alpine slopes; substrate rich in organic matter.
Lecanora lentigera (G. Web.) Ach.; (6/70, 19/70); Sheep Mt.; 3000′; very dry southwest-facing open slope; growing on silt (loess).
Lecanora melanopthalma (Ram.) Ram.; (42/71); Mt. Wallace; 7400′; partially shaded west-facing wall; growing on igneous rocks. New for Yukon.
Lecanora rubina (Vill.) Ach.; (10/70, 41/71); Sheep Mt.; 3000′; metamorphic rock outcropping, dry west side; growing on rocks. New for Yukon.
Lecidea atromarginata Magn.; (47/71); Mt. Wallace; 6600′; dry southeast face; lichen growing on igneous rocks. New for Yukon.
Lecidea cuprea Somm.; (28/71); Mt. Wallace; 7700′; moist alpine plateau; growing on thin layer of mineral soil over igneous rocks.
Lecidea decipiens (Hedw.) Ach.; (2/69, 2/70, 5/70, 38/71); Sheep Mt.; dry, open south- and west-facing slopes; particularly common at low altitudes (2600′-3500′), but also collected from exposed alpine ridges (6000′); usually on silt (loess) deposits.
Lecidea granulosa (Hoffm.) Ach.?; (27/71); Sheep Mt.; 2700′; dry, open south-facing slope; growing on silt. Specimen sterile.
Lecidea marginata Schaer.; (49/71); Mt. Wallace; 7500′; fairly moist southeast-facing wall; growing on igneous rocks. New for Yukon.
Lecidea rubiformis (Wahlenb. ex Ach.) Wahlenb.; (8/70, 9/70, 20/70); Sheep Mt.; 2600′-3000′; dry, open south- and southwest-facing slopes; common lichen covering loess deposits. New for Yukon.
Lecidea tesselata (Ach.) Flörke; (16/70); Sheep Mt.; 3000′; dry, exposed south side of cliff; growing on metamorphic rock.
Parmelia taractica Kremph.; (25/71); Sheep Mt.; 3000′; fairly dry, partially shaded east-facing slope; silt substrate.
Peltigera aphthosa (L.) Willd.; (9b/71); Donjek River-Lynx Creek area; 3500′; moist, shady spruce forest; substrate rich in organic matter.
Peltigera aphthosa (L.) Willd. var. *leucophlebia* Nyl.; (B28/69); Nine Creek; 4000′; shady, moist alder thicket; substrate rich in organic matter.
Peltigera canina (L.) Willd. var. *rufescens* (Weis.) Mudd; (9a/71); Donjek River-Lynx Creek area; 3500′; moist, shady spruce forest; substrate rich in organic matter.
Peltigera canina (L.) Willd. var. *spuria* (Ach.) Schaer.; (33/71); Sheep Mt.; 4000′; patch of spruce near timberline; fairly dry, partially shaded, eastern aspect; silt substrate.
Physcia muscigena (Ach.) Nyl.; (18/70, 24/70); Sheep Mt. and island in Kluane Lake; 3500′, 2600′; dry south-facing slopes; partially shaded; silt (loess) substrate.
Ramalina roesleri (Hochst.) Nyl.; (4/71); Donjek River-Lynx Creek area; 3000′; moist, shady spruce forest; arboreal, on dead spruce branches. New for Yukon.
Rhizocarpon geographicum (L.) DC.; (45/71); Mt. Wallace; 6000′; dry, partially shaded western aspect of wall; growing on igneous rocks.
Solorina saccata (L.) Ach.; (B29/69); Nine Creek; 4200′; moist, shady alder thicket; north-facing slope; substrate rich in organic matter.
Stereocaulon alpinum Laur.; (22/71); Donjek River-Lynx Creek area; 3000′; moist, shady spruce forest; substrate rich in organic matter.

Stereocaulon glareosum (Sav.) Magn.; (13/70, 32/71); Sheep Mt.; 5500′, 6000′; mesic northeast-facing slopes; organic substrate. New for Yukon.
Stereocaulon paschale (L.) Hoffm.; (30/71); Mt. Wallace; 7700′; moist alpine plateau; growing on thin layer of mineral soil covering igneous bedrock.
Stereocaulon rivulorum Wagn.; (6/69); Mine Creek headwaters; 4000′; open, moist spruce forest; north-facing slope; organic substrate. New for Yukon.
Solorina spongiosa (Sm.) Anzi; (37/71); Sheep Mt.; 5400′; dry alpine northwest-facing slope; mineral substrate. New for Yukon.
Thamnolia vermicularis (Sw.) Ach.; (15/71); Donjek River-Lynx Creek area; 3700′; moist, shady spruce forest; substrate rich in organic matter. New for Yukon.
Thamnolia subuliformis (Ehrh.) Culb.; (12/70, 13/71, 14/71, 15b/71); this species was found in a great diversity of habitats, ranging from the high alpine (moist) plateau of Mt. Wallace (7700′) to dry, partially shaded south-facing slopes on the island in Kluane Lake (2600′). Substrate is mineral soil, — loess at low elevations. New for Yukon.
Toninia caeruleonigricans (Lightf.) Th. Fr.; (40/71); Sheep Mt.; 6000′; dry alpine ridge; mineral substrate. New for Yukon.
Umbilicaria havaasii Llano; (1/71); Mt. Wallace; 6800′; moist, shady north-facing aspect of wall; growing on igneous rocks. New for Yukon.
Xanthoria elegans (Link) Th. Fr.; (15/70); Sheep Mt.; 3000′; dry, exposed south-facing aspect of cliff; growing on metamorphic rock.

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Aberrant Coloration in Canadian Eastern Chipmunks, *Tamias striatus*

DONALD A. SMITH and LORRAINE C. SMITH

Museum of Zoology, Department of Biology, Carleton University, Ottawa, Canada K1S 5B6

Abstract. Seven aberrantly colored eastern chipmunks (*Tamias striatus*), three melanistic, two albinistic, one with a white dorsolateral patch, and one with dilute pigmentation, from Ontario and Quebec are described.

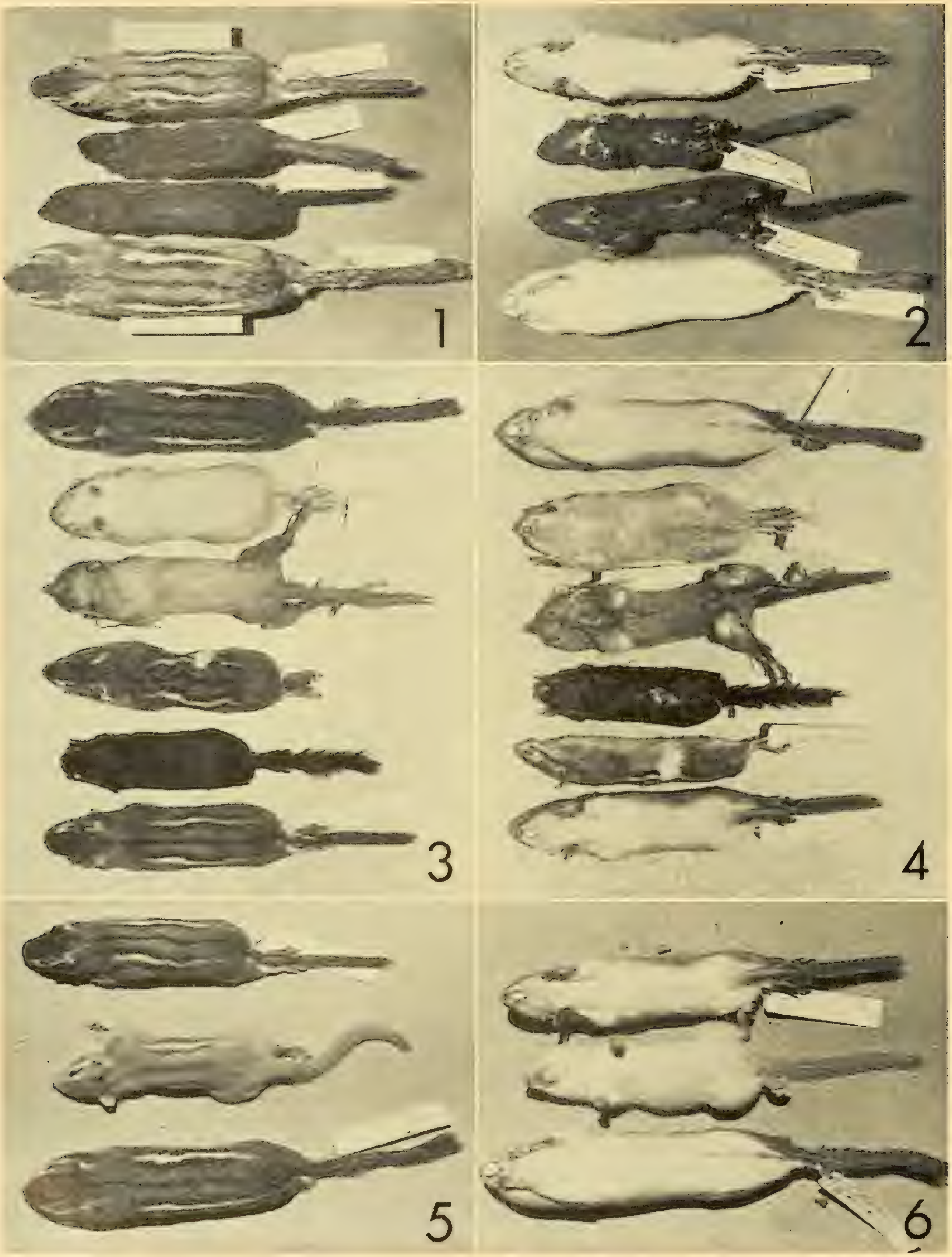
Most of the few published reports of melanism, albinism and other aberrant colorations in eastern chipmunks have originated in the United States. Allen (1938) reviewed most of the scant earlier literature and described two abnormally pigmented chipmunks. Subsequently Stegeman (1960) reported a melanistic chipmunk, and Zinn (1954) and Hough and Smiley (1963) reported albinos. In addition Mossman (1931) described the graying of the fur of four young chipmunks. We know of only one report (by Adams, 1873) of abnormal coloration in Canadian eastern chipmunks. Indeed color aberrations appear to be rare throughout the range of this species.

We examined about 1,450 Canadian chipmunk specimens in the Royal Ontario Museum, Toronto (ROM); National Museum of Natural Sciences, Ottawa (NMNS); and Carleton University Museum of Zoology, Ottawa (CUMZ). We also made some field observations on other mutants. Seven aberrantly colored eastern chipmunks were photographed with two normally pigmented specimens as reference standards. Both the latter were collected on the eastern outskirts of Ottawa, Ontario. CUMZ 2990, the smaller of the two reference specimens in Figures 1 to 6, is an adult female and CUMZ 2996, the larger, is an old adult male whose skin was somewhat stretched in preparation. Our age-class determinations and estimates of the approximate dates of birth of the chipmunks described are based on the criteria in Smith and Smith (1972).

Melanistic Chipmunks

We examined three melanistic chipmunks. NMNS 1391, shown in Figures 1 and 2, was collected on September 13, 1907 near Kingsmere, Gatineau County, Quebec. Other data were not recorded. The specimen is a mounted skin; its small size and the date of collection suggest that it was a young animal born in midsummer. Its dorsal surface is basically dark brown, darkest on the upper back and more rust-colored towards the lower back. The dark brown hairs are ashy gray at their bases. Barely visible because of the abnormally dark ground color are the single black mid-dorsal line, the two pairs of black dorsolateral lines and the three dark facial stripes. The ordinarily light buff dorsolateral and facial stripes are still faintly visible because buff bands below the tips of the dark hairs give the appearance of fine buff speckling. Also basically dark brown with faint buff speckling are the sides and ventral surface. A longitudinal white throat patch about 22 $\times$ 4 millimeters is visible in Figure 2. The transverse white area on the throat and that on the mid-belly, both also seen in Figure 2, are artefacts, being merely stuffing material showing through rips in the skin. The tail is almost normal, differing from that of CUMZ 2290 only in having fewer hairs with buffy tips and in being duller ventrally.

NMNS 1019 is a mounted skin with skull enclosed of a female collected February 10, 1902 at Norway Bay Park, Ontario by David McFarlane. The early date of collection and large size suggest that it is an adult. Figures 1 and 2 show that it is almost uniformly dark including its tail. Its hairs are dark brown with gray bases. Close inspection reveals the black mid-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dorsal line. Slightly lighter brown hairs indicate the position of the ordinarily light dorsolateral lines. There is a small white spot on the chin, another on the chest and a few isolated white hairs on the sides.

Both these melanistic chipmunks (NMNS 1019 and 1391) are mounted specimens that may have been on display for some time after preparation. Thus their pelage may have faded or 'foxed' considerably from the original dark color. In contrast, the skin of the third melanistic chipmunk we examined, ROM 21427, shown in Figures 3 and 4, had not been displayed, and its fur is totally black. The light areas on its venter in Figure 4 are either exposed skin or stuffing material. This midsummer-born subadult female was taken on October 12, 1951 by S. Plooffe in Township 22, Sudbury District, Ontario and donated by the Ontario Department of Lands and Forests.

The only previous report of melanistic eastern chipmunks in Canada is that of Adams (1873; page 100) who saw 'several instances of melanism in this species' in New Brunswick. There are several records of melanistic chipmunks from the United States. Specimen MCZ 1592 in the Museum of Comparative Zoology at Harvard University, collected at Norway, Maine, was described by Allen (1877) as black with a narrow white streak on the breast. This appears to be similar to the marking on NMC 1391 described above. Allen (1938) examined a completely black chipmunk taken at Richford, New York on May 10, 1929, and also mentioned (page 15) that 'a few strongly melanistic specimens are . . . in the (United States) National Museum collections at Washington, D.C.'. The melanistic chipmunk reported by Stegeman (1960) was taken at Middleville, New York about October 19, 1958. He described this male as coal-black with a few short white hairs on the back and cheeks. Its measurements suggest that it is a large young or small adult born in midsummer.

Albino Chipmunks

Figures 3 and 4 show that two albino chipmunks in the Royal Ontario Museum have no evidence of stripes nor any other pattern. The whiter of the two albinos, ROM 31269, is a male taken on October 4, 1958 by Fred Schlick at Hamilton, Ontario. Its size is within the normal adult range. Its color is a slightly buffy white, somewhat grayer with accumulated dirt on the ventral surface. The light patches on the venter in Figure 4 are areas where the fur has been lost. The dried ears and feet are considerably lighter and more translucent than those of the two normally pigmented specimens. The vibrissae are white.

The second albino, ROM 12652, was taken at Feversham, Grey County, Ontario. The date of collection is unknown but the mounted skin with skull enclosed was donated by O. E. Devitt in August, 1938. It was likely on display for some time and is now a dirty yellowish-gray, considerably darker on the ventral surface. When small areas of the tail, back, side and belly were washed with water and a mild detergent to remove the accumulated grime (after the photographs were taken), the fur in each of these places was seen to be a buffy-yellow color, considerably more intense than that of ROM 31269. The white patches seen at the base of its limbs in Figure 4 are merely stuffing

FIGURES 1 and 2. Dorsal and ventral views of two melanistic chipmunks between two normal specimens. From top to bottom, specimens are: CUMZ 2990, NMNS 1391, NMNS 1019, CUMZ 2996.

FIGURE 3. Dorsal views of two albino chipmunks, one melanistic and one with a white dorsolateral patch, with two normally pigmented specimens. From top to bottom, specimens are: CUMZ 2996, ROM 31269, ROM 12652, CUMZ 5001, ROM 21427, CUMZ 2990.

FIGURE 4. Ventral views of two albino, one melanistic and two normal chipmunk specimens, and lateral view of one specimen with a white dorsolateral patch. From top to bottom, specimens are: CUMZ 2996, ROM 31269, ROM 12652, ROM 21427, CUMZ 5001, CUMZ 2990.

FIGURES 5 and 6. Dorsal and ventral views of a live dilute-pigmented chipmunk (temporarily etherized) between two normal specimens, CUMZ 2990 (top) and CUMZ 2996 (bottom).

material protruding through tears in the skin. The opacity of the ears and feet is intermediate between that of the whiter albino and that of the two normal specimens but tends to be more similar to the latter. The vibrissae are dark.

Allen (1938) found no records of albino chipmunks but two have appeared subsequently. Zinn (1954) reported that two albino chipmunks, one of each sex, were caught two weeks apart at South Kingstown, Rhode Island in April, 1953. They were entirely white and had pink eyes. He implied that they occupied the same burrow. If so, we would speculate that they were littermates, possibly born the previous midsummer, that overwintered together, rather than a breeding pair as Zinn implied. A white female chipmunk killed on May 14, 1961 near Kingston, New York, was reported by Hough and Smiley (1963). Its measurements, weight and date of capture indicate that it was an adult. It had pink eyes and although its general color was white, it had irregular patches of cream to buffy brown on the head, back and the dorsal aspect of the tail.

Other Aberrantly Colored Chipmunks

We observed two abnormally pigmented eastern chipmunks in the vicinity of Ottawa, Ontario. One, an old adult male, (CUMZ 5001) was live-trapped at Stanley Corners almost daily from April 20 to June 26, 1970. Its pelage was normal until June 9 when we noticed a small patch of bare skin on the right side. The bare patch increased in size, and on June 23 white fur was observed in the area. By June 26, when the animal died accidentally, the 15 $\times$ 25 millimeter patch was fully covered with pure white fur (Figures 3 and 4). The factors that caused this chipmunk to lose some of its fur and then grow in white replacement fur very rapidly are not known. All of the many other chipmunks live-trapped in this woods during the past four years, including a litter of five fathered by this aberrant male, were normal in color and pattern. We encountered only one previous record of a chipmunk with a white spot; one of Allen's (1938) New York specimens had a white spot located posteriorly in the left dorsal stripe.

The second aberrant chipmunk we observed was normal in pattern but all its colors were considerably diluted, so that it was very pale indeed. Figures 5 and 6 show how much paler it was than the two normal chipmunks collected within two miles of its birthplace. The general dorsal and lateral color was pearly gray with buffy overtones, with white and 'washed-out' brown stripes. The ventral surface was white. Both the dorsal and ventral sides of the tail were the same frosty grayish brown, slightly browner than the back. The vibrissae were whitish, and the nose, snout, lips, chin and feet distinctly bright pink. Its eyes were dark reddish-brown, lighter than the eyes of normal live chipmunks but much darker than the red or pink eyes of albinos.

This pale female chipmunk was in a litter of six which emerged from a burrow in a suburban Ottawa garden in June 1971. Three young were normally pigmented like their mother and three were identically pale. A midsummer litter produced by the same female contained only normally pigmented young. We speculate that the lack of normal melanin complements in the pale chipmunks must be due to their genetic make-up and that a 'white' or 'beige' chipmunk seen in the neighbourhood by others during 1970 and 1971 may have sired the spring litter containing the pale offspring.

Reports of dilute coloration in eastern chipmunks are very scarce. Allen (1877) reported that MCZ 1568 from Maine had pale, obscure stripes; this specimen may be similar in some respects to the live pale chipmunk we examined. Mossman (1931) described changes in the pigmentation of four young chipmunks from the normal colors to silver gray with dull stripes after six or more weeks in a cage in direct sunlight. He thought that moulting was involved in this color change, and that direct sunlight was the probable causative agent. His animals lost the hair on their tails as they became grayer and at least three of them died shortly thereafter. His observations have apparently never been duplicated nor satisfactorily explained. The Ottawa area case is a different one for the dilute individuals were pale and healthy when they emerged from their natal burrow and ap-

peared so for the ensuing two months of observation. This appears to be the first report of what is probably a genetically controlled dilution of the normal pigmentation in *Tamias striatus*.

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History and Economic Importance of the White Fox, *Alopex*, Fur Trade in Northern Alaska 1798-1963

David L. Chesemore

Oklahoma Cooperative Wildlife Research Unit,
Oklahoma State University, Stillwater, Oklahoma 74074, U.S.A.

Abstract. The fur trade in white fox, *Alopex lagopus,* developed in northern and western Alaska in conjunction with whaling but became important only after 1900 when whaling was no longer profitable. Intensive fox trapping occurred in Alaska during the "fur boom" of the 1920's until the 1929 depression destroyed the market for wild furs. Since 1929 a steady decline in pelt value and total harvest of white fox has occurred and today, with a few local exceptions, the trapping of this furbearer has little impact on the economy of Alaska.

Introduction

The trapping of white arctic foxes, *Alopex lagopus,* is the primary, and often only source of earned income for many Alaskan Eskimos living in northern and western Alaska. Although the encroachment of modern civilization continues to reduce the dependence of Alaskan natives on existing wildlife resources, fish, game, and furbearers still play a major economic role in their lives. Data on economic conditions and fur harvest were collected during September 1961 through March 1963 and discussion of these data is inclusive of this period. Recent petroleum developments in the Alaskan Arctic undoubtedly will have considerable impact on the native economy of the area but no attempt has been made in this paper to analyze the effects of these new forces. Only the continental arctic or white fox *A. l. innuitus,* has been studied here (Hall and Kelson 1959).

In Alaska, the white arctic fox is found along the coast from the Kuskokwim River north to Point Barrow and eastward along the arctic coast to the Alaskan-Canadian border. White foxes also occur on St. Lawrence, St. Matthew, Hall, and Diomede Islands, as well as on many of the other islands in the Bering Sea. Few occur among the predominantly blue arctic foxes found on the Pribilof and Aleutian Islands. White foxes have been trapped in the Alaskan Interior but most of the white fox population lives in the tundra and coastal plain areas of northern and western Alaska (Chesemore 1968). Preference for tundra conditions, and perhaps interspecific competition with the red fox, *Vulpes vulpes,* are possible factors determining the existing distribution of white foxes in Alaska.

History of the Alaskan White Fox Fur Industry

It was Alaska's natural wealth of furs, particularly those of the sea furbearers, that first brought the white man to this part of the world (Rogers 1962). The earliest to arrive were the Russian *promyshlenniki,* drawn by the large sea otter, *Enhydra lutris,* and fur seal, *Callorhinus ursinus,* populations. Spanish, French, English, and American adventurers followed the Russians, and all began the well-documented exploitation of the sea otter, fur seal, whale, and walrus, *Odobenus rosmarus,* populations.

The first authentic list of fur shipments from Alaska was compiled at the beginning of the nineteenth century by a Russian Navy Lieutenant, Vassili Berg (Petroff 1898). He had access to the archives of Petropavlovsk, Nishnekamchatsk, Bolsheretzk, and Okhotsk, and recorded the Alaskan furs received in these ports during 1745 to 1797. Siberian traders were shipping pelts of the blue or maltese arctic fox as early as 1745, but not until 1798 are there records of the white fox in the Russian fur trade.

The Russian-American Company, established in 1797, periodically published reports of furs it exported from Alaska. These records furnish the best available information about the fur harvest in Alaska from 1797 until 1867

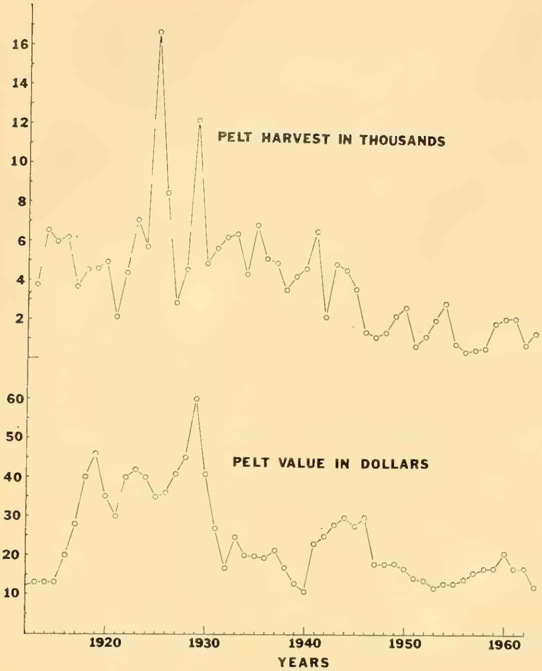

FIGURE 1. Annual average white fox harvest and pelt values in Alaska from 1912 to 1963.

(Table 1). These data must be considered as minimum estimates of the actual fur harvest. These totals do not compensate for losses of pelts that must have occurred from shipwreck, or spoilage of pelts; nor do they include the number of pelts taken by illegal trading of the independent traders operating along the arctic coasts (Petroff 1898). There is no accurate estimate available on the amount of illegal trade that was occurring in Alaska, but Petroff (1898) states that "From the persistency with which these men continue to assume the risks of this unlawful trade . . . both its volume and profit are large."

After the American purchase of Alaska in 1867, average prices of all furs increased greatly. The low fur prices paid by Russian traders were the result of little or no outside competition, while the sharp rise of fur values after Alaska's purchase may be attributed to the increased competition between traders. Because of this competition of traders the purchasing power of money did not decrease in proportion to the increasing fur prices. This allowed an economically healthy fur trade to develop in the newly acquired Territory of Alaska.

White fox pelts rose in value almost 900 percent after 1867, increasing from an average price of $.20 to $2.00 per pelt (Petroff 1898). At this same time, the average price of a white fox pelt on the London fur market was approximately $3.00. The low dollar value of this fur during a period of relatively high prices for other furs probably was caused by fashion's disinterest in the fox pelt. The fur's low durability, only 40 percent of that of sea otter fur, was also a liability. White fox fur shows a marked depreciation in quality after being used for several years (Bachrach 1953).

It was in conjunction with the whaling industry that the white fox fur trade developed in northern and western Alaska. American whalers first appeared off the Alaskan coast about 1820, and in 1833 a Yankee whaler stopped at Sitka to recruit Aleuts for whaling in the arctic waters (Hulley 1958). Charles D. Brower began trading with the natives along the arctic coast in 1882, and 1884 he established the Cape Smythe Whaling and Trading Company at Barrow (Brower 1942). He first bought a few

TABLE 1

Number of furs shipped from Alaska from 1745 to 1880[1]

Fur	1745–1867[2]	1867–1880[3]	Total
Fur seal	3,354,478	1,277,333	4,631,811
Land otter	2,444,538	25,331	2,469,869
Beaver	413,356	58,258	471,614
Sea otter	260,790	52,491	313,281
Red fox	147,917	114,633	262,550
Blue fox	204,791	11,927	216,718
Cross fox	102,410	25,624	128,034
Black fox	83,593	9,302	92,895
White fox	45,891	15,804	61,695

[1]Petroff, Ivan. 1898. Report on the population, industries, and resources of Alaska *in* Seal and Salmon Fisheries and General Resources of Alaska. 55th Congress, Doc. No. 92, House of Representatives. Vol. 4, pp. 167-450.
[2]Harvest of Siberian traders, Shelikof Company, and Russian-American Company.
[3]Harvest of American traders only.

white fox furs in 1882 but intensified this fox trading in the early 1900's after commercial whaling ceased to be economical.

Commercial whaling reached a high in the Barrow, Wainwright, Point Hope, and Point Lay areas in 1900, and then suffered a slow, continuous decline until its eventual end in 1910 (Brower 1942; Spencer 1959). A considerable number of white fox pelts may have been obtained by whalers during their operations along the arctic coast, but no reliable records exist showing the volume of this trade.

After World War I, fox trapping became the primary economic activity in northern Alaska and continued to be the most important source of income in this area for the next 12 or 13 years (Spencer 1959). The sharp 1920 increase in fur values, due primarily to the economic boom in luxury goods following World War I, prompted the Eskimos to begin intensive fox trapping along the arctic coast. Spencer (1959) states that during the 1920's white fox pelts sold for an average price of $50.00 each. Mr. Thomas Brower (*viva voce*), a storeowner at Barrow Village, states that $55.00 was the top price paid for fox pelts to native trappers by the Cape Smythe Whaling and Trading Company during that decade. One native trapper is reported to have earned $8,000 during the 1927 trapping season, mainly from white fox furs, indicating the potential amount of income existing under the inflated fur prices. This increased economy replaced the lost whaling income and began to improve the Eskimo standard of living.

In 1929, the Cape Smythe Whaling and Trading Company purchased 12,000 white fox pelts from the Arctic Slope, paying $35.00 for the best pelts (Brower, *op. cit.*). This was the largest number of white fox furs ever purchased in one year by Brower's company during its many years of trading in northern Alaska. Its trading posts bought furs at Barrow Village, Barter Island, Beechey Point, and Point Lay, and were the only established stores in the area until the Native Cooperative Stores developed in the late 1920's.

The 1929 depression destroyed the market value of white fox and other furs, and arrested the economy of Eskimo trappers in northern Alaska. Some residents of Barrow also maintain that it was the importation of Russian furs that helped, if not initiated, the fall of fur prices in 1929. However, fox imports from Russia remained almost constant during the 1920's and early 1930's and do not show an expected increase indicating that the fur market was truly glutted during this period with Russian fox furs (U.S. Dept. of Commerce 1930, 1936).

White fox pelts in 1931 brought only $5.00 or less forcing formerly wealthy fox trappers to revert to subsistence hunting and dependence upon sea mammals for food. A few Eskimos continued to trap, but the combination of low prices and light trapping pressure resulted in a greatly reduced harvest of this species for the following years. White fox pelts have never again been as valuable as during the fur boom of the 1920's.

Economic depression continued in the Barrow area until 1946, when the United States Navy began extensive oil explorations on the Arctic Slope. This operation provided full-time employment for approximately 75 to 80 Eskimos from 1946 until oil exploration ended in 1952 (Roberts 1954). It was during this period that one of the lowest recorded Alaskan white fox harvests occurred. Fur records show that only 654 white foxes were exported from Alaska in 1951, in comparison with 16,658 in 1925. It appears that the low pelt value and high Eskimo employment may have been important factors in reducing the fox harvest in northern Alaska.

Status in Alaska, 1961-1963

Harvest Statistics

Harvest estimates are based on fur export and fur buyer reports filed by fur buyers when purchasing or exporting raw furs from Alaska. These records serve as indicators rather than as exact records of fur harvest in the state. Failure of fur buyers to keep accurate records and report all of the furs purchased during the year and reluctance by trappers to report their annual take of furs hinders the development of adequate harvest information and at best makes these data approximate. Comparison of

TABLE 2

Harvest of white fox at Barrow Village and Wainwright, Alaska (1960–1963), based on the number of fox skins purchased by the village stores[1]

Year	Village						
	Barrow			Wainwright			
	Male	Female	Total	Male	Female	Total	Total Harvest
1960–61	225	264	489	[2]/	[2]/	[2]/	489
1961–62	110	116	226	340	291	631	857
1962–63	61	54	115	218	145	363	478
Total	396	434	830	558	436	994	1,824
Average	132	145	277	186	145	331	608

[1]Data collected by store owners at respective villages.
[2]No record kept at village store during 1960–1961.

harvest estimates based on fur buyer reports and on fur export records indicates that the former are consistently lower than the latter.

Considerable variation exists in the yearly harvest of Alaskan white fox (Figure 1). From 1912 to 1963, Alaska sustained an average annual harvest of approximately 4,000 white fox pelts. Of the estimated total harvest for 1960 to 1962, 86 percent was shipped to fur buyers outside of Alaska, indicating that most Alaskan white fox furs are sold and utilized outside of Alaska. There is little local market for these pelts other than in the manufacture of tourist souvenirs and decorative trims for parkas, mukluks, and slippers.

Distribution of Harvest

To determine the distribution of the white fox harvest in Alaska the state was divided into three geographic areas: the Arctic Slope, encompassing the area north of the crest of the Brooks Range; Islands, primarily those located in the Bering Sea off the western coast of Alaska; and western Alaska, that portion of the state bordering on the Bering Sea and extending south of the Arctic Slope into the Bristol Bay region.

The Islands produce the highest catch of white fox per unit area with St. Lawrence Island producing more fox pelts than any of the other Alaskan islands. Based on data taken from the 1959 to 1962 fur export records, 31 percent (898 pelts) were shipped from the Islands, while 42 percent (1,138 pelts) were exported from the Arctic Slope. The remaining 27 percent (798 pelts) of the white fox harvest exported during this period were obtained from western Alaska.

Harvest on the Arctic Slope

To determine the white fox harvest in northern Alaska, a store tally was organized during 1960 to 1963 in stores buying furs at Wainwright and Barrow Village. The store owners conducted this count, tallying the sex and number of white fox pelts purchased each month during the trapping season and on into the spring after the close of the trapping season. As shown in Table 2, 1,824 white fox pelts were purchased by these stores during the three trapping seasons involved. It is interesting to note that in 1962 the store tally of 857 white fox sold at Barrow Village and Wainwright exceeded the published state harvest of 776 pelts. Contact with those conducting the store tally at Barrow Village and continued correspondence with the men at Wainwright leave little doubt that the store tallies were reasonably accurate. About 90 percent of the foxes taken by Barrow Village trappers are sold at the local stores,

with the remainder being used in local homes or sold outside of Barrow Village to itinerant fur buyers. A few pelts may be sold to tourists during the summer months.

Value of White Fox Furs

Trapping effort showed a direct relationship to pelt value and variations in the annual harvest of white fox also reflected these fur prices (Figure 1). White fox pelts have reached values over \$50.00 but usually sell for less than \$20.00. Between 1912 and 1963, an average price of \$24.18 per pelt was maintained with the highest average price, \$60.25 obtained in 1929, and the lowest price, \$12.50 received in 1963. Prices for white fox pelts at Barrow Village have declined in recent years. In 1959-60, 681 pelts brought an average price of \$30.00 cash or credit at local stores but in 1960-62 sold for \$17.00. Pelts sold to tourists had an average price of \$20.00.

Although advertised values for raw furs may show general price trends, these prices do not accurately indicate potential trapper income. Few furs succeed in meeting the top grades of the fur buyer and thus actually received the premium prices advertised in fur buyer brochures. Most furs are graded as middle and low grade furs. White fox pelts from northern and western Alaska bring higher prices than do those taken in the lower Yukon-Kuskokwin River Areas. Increased pelt size and quality of fur apparently are responsible for this differential in price between these areas.

Economic Importance of the White Fox

Based on the 1925 to 1962 summary of fur values and harvest (Table 3), the white fox ranks fourth in average pelt value and sixth in over-all harvest value when compared with the ten other common land furbearers in Alaska.

Only 5 of the 11 economically important land furbearers found in Alaska regularly occur on the Arctic Slope: red fox, white fox, wolf, *Canis lupus,* weasels, *Mustela* spp., and wolverine, *Gulo gulo.* Although these furbearers occur throughout the Arctic Slope, all, except the white fox, are uncommon in the area or tend to concentrate in the foothills and mountains

TABLE 3

Average annual fur harvest within Alaska from 1925 through 1962[1]

Furbearer	Average price per pelt in \$	Average yearly harvest	Average harvest value in 1,000's of \$
Mink	20.23	36,640	741
Beaver	23.10	18,070	417
Muskrat	1.23	207,207	253
Red Fox	13.16	11,014	145
Marten	28.89	5,187	139
White Fox	22.96	3,888	89
Lynx	28.60	2,293	66
Otter	20.80	2,805	58
Weasel	1.38	8,185	11
Wolf	20.50[2]	642	45
Wolverine	17.84	378	6

[1]Koontz, K. 1968. Small game and furbearers of the Rampart Dam Impoundment Area. Unpublished M. S. thesis, University of Alaska, College.
[2]\$50.00 bounty payment added to average pelt price to determine over-all harvest value.

of the Brooks Range. Few trappers penetrate these latter areas during the winter. Adverse winter conditions and the location of most villages along the coast restricts most of the harvest of fox on the Arctic Slope and in western Alaska to coastal areas.

Consequently, because of a relatively high pelt value, periodic high populations, and availability to local trappers, the white fox is the only furbearer of economic significance on the Arctic Slope of Alaska.

Economic Conditions at Barrow Village, Alaska

Barrow Village's economic structure was studied in three ways: by personal interviews with residents; questionnaires mailed to village trappers; and a review of the pertinent literature.

Description of Barrow Village

Barrow Village lies north of the Arctic Circle on the northernmost point of land in the United States. It is the largest Eskimo village in North America, and in 1960 had a native population of 1,314 (U.S. Bureau of the Census 1961). Like other native villages in Alaska, Barrow Village is in a state of economic and social

TABLE 4

Sources and amount of unearned income at Barrow Village, Alaska during 1962[1]

Unemployment compensation	$ 53,373
Social security	22,800
Bureau of Indian Affairs general assistance	24,535
Welfare payments	
Old age assistance	29,652
Aid to the blind	1,176
Aid to dependent children	56,064
TOTAL	$187,600

[1]Information from personal communications with various agencies responsible for the administration of this aid.

change. This change, from independent subsistence hunting to reliance on monetary means for survival has produced a complex mosaic of social and economic reactions in the Eskimo community. No native village, regardless of similarities in location, size, or past history, can accurately be compared economically or sociologically with another. Each has evolved separately and uniquely in the characteristically harsh environment of Alaska and under varying degrees of contact with white culture and values.

Woolford (1954) states that some of the variables affecting a native economy are: availability and extent of local and outside employment; and the degree of dependence upon government aid for the relief of children, the aged, and the unemployed. Geographic location, tribal customs, length of association with whites, educational advancement, and general health conditions also influence village economy.

Barrow Village falls into the Class 2 village used by Woolford:

> In this category are the villages characterized by long association with the whites. Local industries and activities of the whites have provided a substantial amount of seasonal employment and to lesser degree, continuous employment. Villagers have become dependent upon one another for services such as furnishing and hauling water and fuel. The wildlife resource is heavily utilized and all available sources of government disbursements for relief are avidly tapped. . .

In a generation, Barrow Village has changed from almost a total hunting economy to one where only 25 percent depend primarily on hunting (Kittiktokti 1962). Now Barrow Village's economy is based on federal government operations: the U.S. Navy's Arctic Research Laboratory, U.S. Air Force, Federal Electric Company, Puget Sound and Drake, U.S. Weather Bureau, Bureau of Indian Affairs (BIA) aids, U.S. Public Health Service facilities, and state welfare checks. Federal and state welfare aids comprise a large part of the annual income. Barrow Village's total unearned income for 1962, from unemployment compensation, social security, BIA general assistance, and welfare, was $187,600 (Table 4). This amounts to an average unearned income during 1962 of $1,042 per family in the village.

Barrow Village's living costs are high. A cost-of-living estimate was obtained from Barrow Village prices listed for basic supplies, food, fuel, and ammunition, that are required for minimum family subsistence. Twelve food items costing $27.70 at Barrow Village were only $12.96 in Seattle, Washington. Computed at Barrow Village prices, 18 basic items cost $40.20, but the same items were only $28.70 in Fairbanks. The cost of living in Barrow Village is 40 percent greater than that of Fairbanks. However, all items at Barrow were not equally inflated in price: food prices were 14 percent above Fairbanks prices, ammunition costs were equal, and fuel costs were 88 percent higher than in Fairbanks. Because most Eskimo families do not use a planned budget, it is difficult to estimate the income needed for a satisfactory living standard.

Spencer (1959) learned during his study of Barrow Village in 1952-53 that a family of five, having an ample supply of game, could spend between 50 to 140 dollars a month for food, depending on how much the group was using introduced store foods. If no game was available, food costs could reach 300 dollars a month. Assuming the family purchased only staples, spending approximately $40.00 a week, the yearly food cost for five persons at Barrow Village would be $1,920.

An estimate of heating requirements for a three-room frame dwelling in 1952-53 was 5 gallons of fuel oil per day (Spencer 1959). Assuming that the full heating cost would be borne for 8 months, heating such a home would cost $780.00 a year. Ten years later, Bowler (1962) estimated that the average heating cost of the families at Barrow Village was $1,147 a year.

No accurate figures for the exact living costs of additional income received by Eskimo families from the sale of crafts, wild game, or subsistence gained by trading or working for needed items are available for Barrow Village residents. Eskimo community spirit provides for many of the less fortunate members of the Barrow Village Community, but just what impact this action has on the area's economic picture is unknown. It may result in additional expenses for those families which are obtaining sufficient income to meet their needs, and could lower their standard of living accordingly. Van Stone (1962) reports this result in family interactions at Point Hope, Alaska.

It is clear that most of Barrow Village's Eskimo families have low dollar incomes while facing high living costs. Dollar income does not always match dollar expenses, but the substitution of subsistence gains for monetary needs has helped shorten, if not bridge, this gap. Barrow Village is essentially functioning under two economies: a money economy and a subsistence economy. It is those families who can best adapt to both systems that are enjoying a high standard of living in the village today.

Importance of White Fox in the Barrow Economy

Few Barrow Village men are now trapping regularly. During the 1962-63 trapping season, 39 trapping licenses were sold at the Barrow Native Cooperative Store, the only store in the village selling them. It was indicated in conversations with local residents that almost all who were trapping bought trapping licenses. Of these 39 men, 25 answered the trapping questionnaire that was mailed to each. Of those answering the questionnaire, only six men stated they were trapping regularly, while five more reported that they were trapping part-time. Mrs. Sadie Nayakok, deputy magistrate at Barrow Village (*viva voce*) estimated that there were no more than 10 or 20 men trapping full-time in the village during the 1962-63 season. Similar estimates were also given by other residents in the area. Full-time employment, poor health, the low price of fur, and bad weather were the main reasons given for not trapping regularly. Those trapping part-time were all employed full-time by various agencies around the Barrow Village community.

Few young men are now trapping in the Barrow Village area. The average age of the 36 Eskimos purchasing trapping licenses at Barrow Village was 42 years (range 24 to 70 years). The average age of the 11 men trapping either full- or part-time was 47 years. As noted by Hughes (1960) trapping skills are not being passed on to the young men. Mr. Charlie Edwardson (*viva voce*), a teen-age resident of Barrow Village, felt that a young man who is not raised in a subsistence hunting and trapping environment and who has no guidance or previous experience in fur trapping has only a 50:50 chance of succeeding financially at trapping.

A significant change in white fox trapping procedure has developed from that used in the 1920's when two or three families located a central trapping camp, 16 to 24 km from other trapping camps along the coast, and each family member trapped an equal portion of the surrounding area (Jenness 1957). Now, the families remain at Barrow Village while the trapper goes on the trapline.

During the trapping season of 1961-62, an average of 73 traps (range of 6 to 200 traps) per trapline was maintained by Eskimo trappers of Barrow Village. Trapline lengths varied between 8 and 280 km, having an average length of approximately 101 km. Part-time trappers maintained shorter traplines, usually less than 16 km long, and used an average of 12 traps on each line.

Three forms of transportation were used by Barrow Village trappers to check traplines: motor vehicles, such as snow travelers, tracked vehicles ("weasels"), and snowmobiles (48 percent); dog teams (30 percent) and walking

(22 percent). The longest routes traveled by dog teams usually ended approximately 120 km from Barrow Village, with the greater distances, up to 280 km of trapline, being completed with motor vehicles. The majority of trappers checked their traplines at least once a week (13 of 15) while only 1 out of the 15 reporting did not check his traps for at least a month after setting them.

Over many years, an average catch of 56 foxes per trapper was reported from the Barrow area. Jenness (1957) noted that in the 1920's trappers took between 20 and 50 foxes during a season while averages of 50 and 100 foxes per trapper are known from St. Lawrence Island (Hughes 1960). One trapper at Barrow Village, known as one of the best in the village, took over 150 white foxes during the 1959-60 trapping season. Trapping success is dependent on a number of factors: skill of the trapper, density of foxes, weather conditions, length of trapline, and perhaps chance. With reasonable effort, it could be expected that in an average year a Barrow Village trapper would take around 50 white foxes.

White fox, red fox, wolverine, wolf, polar bear (*Ursus maritimus*), and dogs (*Canis familiaris*) were listed as known destroyers of white foxes in traps. Losses varied directly with the care a trapper exercised in checking his traps regularly, but most trappers lost at least 1 to 5 white foxes each year to this depredation.

Thirteen trappers stated that they usually caught at least one or more unprime foxes, primarily young animals, during the first few weeks of trapping season. White foxes usually remain economically prime until the 1st or 2nd week in April. Stains from the fat of sea mammals turn the white fur pale yellow and badly stained fox pelts are often discounted by fur buyers up to 50 percent of their original value. Foxes taken on the sea ice often have these fat stains on their fur.

Home utilization of this species is low, consisting usually of 1 to 5 pelts per family. Ruffs and trim for clothing are frequently made from damaged pelts. These pieces sell for about $10.00, thereby salvaging some of the loss that might occur if these damaged pelts were sold intact. Families often keep damaged pelts for their own use rather than sell them for a low price.

Trends in Barrow Village's Economy

Increasing construction and oil exploration on the Arctic Slope will continue to provide more full-time employment for Barrow Village residents. During the winter of 1962-63, 40 percent of the Barrow Village men were employed full-time, and another 25 percent were employed part-time.

Due to increased employment, trapping effort for white fox and other furbearers probably will continue to decrease. Market hunting and the sale of game, mainly seals and caribou, *Rangifer tarandus*, to the employed who lack time to hunt for their own families, may continue to provide increasing income for the remaining subsistence hunters of the village. Only a marked increase in fur prices, raising trapping income to a comparable level with available construction incomes, could cause the resumption of intensive fur trapping at Barrow Village. In other villages of northern Alaska lacking employment opportunities now available at Barrow Village, white fox trapping often is the only source of earned income for villagers during the winter months.

Acknowledgements

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Additions to the Flora of Alberta[1]

JOHN G. PACKER and MADELEINE G. DUMAIS

Department of Botany, The University of Alberta, Edmonton, Alberta

Abstract. A list of 136 vascular plant species is presented. They represent additions to the flora of the province recorded since publication of Moss's 'Flora of Alberta'.

Introduction

The publication in 1959 of the 'Flora of Alberta' by E. H. Moss was a significant landmark in the study of the Canadian flora. Especially important though it is to westerners, it was an important event nationally and internationally. Before Moss's work, there existed not even a check-list of the flora of the region, which as Moss correctly observes in his preface 'affords features of exceptional botanical interest'. The work is certainly not without imperfections, but these can be ignored in a pioneering effort that at once provided, not only an inventory of the flora, but keys for identification and descriptions for the species in an area of over 255,000 sq. miles.

The publication of the flora could not have been more opportune. Its completion after 35 years of study on the eve of a decade that began with an expansion of universities unparalleled in Canadian history and ended with a widespread public concern for environmental quality that many had despaired would ever become manifest, was a felicitous coincidence. There can hardly be any doubt that both these factors have affected considerably the tempo of investigations in the flora of Alberta which has accelerated most gratifyingly over the past ten years. Today, more than at any time in the past, the flora is under active investigation by both taxonomists and ecologists. It is as a consequence of this activity that additions to the flora are being made almost continuously.

The importance of Moss's flora as a standard reference work in studies of the flora of Alberta makes it highly desirable to periodically review new records for the province, thus keeping a relatively up-to-date checklist. There are now some 136 additions to the flora, as published in 1959, a sufficient number to justify the publication of such a compilation at this time. Information concerning the occurrence in Alberta of species not included in Moss's flora is derived mainly from the literature and the herbarium collections of workers actively involved in the study of the flora. Moss's own collections are an occasional source for additions that were originally obscured by misidentification.

As regards literature records, there are three main sources. Boivin (1966, 1967) is of prime importance and his 'Énumération des plantes du Canada' includes many additions to the flora of Alberta. Prior to this publication, Moss & Pegg (1963) covered a number of species that they recorded in Alberta in the years immediately following the publication of Moss's flora. The other major literature source is the work of Porsild (1959) listing the species in the Sunshine Valley area of Banff National Park. These and other literature records while available are not always readily accessible and it seems desirable to include them here, so that all the additions of the flora of Alberta since 1959 are included in a single comprehensive list. In the following compilation, only newly described species or those previously unrecorded in the province are included. Thus species 'additional' by virtue of nomenclatural changes or adoption of species concepts differing from those of Moss but which were treated by him in some way and recognized as occurring in Alberta, are excluded. Consideration of these must await a complete revision of the flora.

The following list is divided into two parts to distinguish the native species (100) from the introduced, non-native species (36). For native species, the publication in which the species is

[1]This work has been funded by the University of Alberta and NRC Grant No. A2582.

first unequivocally recorded for the province is cited following the species name. Citation of specimens is restricted to collections of native species deposited in the University of Alberta herbarium (Alta), exclusive of those previously cited by Moss & Pegg (l.c.).

SPECIES LIST

Native Species

OPHIOGLOSSACEAE

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Cadomin. E. H. Moss 10318, Aug. 2, 1953.
Lake Norman, Banff National Park. J. G. Packer. Aug. 21, 1958.
Whitecourt Mt. J. G. Packer. June 12, 1960.

Botrychium dusenii (Christ.) Alston
Fort Saskatchewan. G. H. Turner 7546, June 27, 1951.
North of Gunn. G. Pegg. June 29, 1960.
Wildhay River, Willmore Wilderness Park. J. G. Packer 3416, July 27, 1965.

POLYPODIACEAE

Dryopteris phegopteris (L.) Christ. Reported by Ogilvie (1962).
Swan Hills. J. G. Packer & M. G. Dumais. Aug. 25, 1970.

SPARGANIACEAE

Sparganium glomeratum Laest. Reported by Moss & Pegg (1963).

Sparganium hyperboreum Laest. Reported by Porsild (1959).

NAJADACEAE

Potamogeton obtusifolius Mert. & Koch. Reported by Moss & Pegg (1963).

Potamogeton robbinsii Oakes. Reported by Boivin (1967).

HYDROCHARITACEAE

Elodea longivaginata St. John. Reported by Boivin (1967).

GRAMINEAE

× *Agroelymus hirtiflorus* (Hitch.) Bowden. Reported by Bowden (1967).
Meander River, Mackenzie Highway. E. H. Moss 8925, July 16, 1949.

× *Agroelymus mossii* Lepage. Reported by Lepage (1965).
Lake Louise, Banff National Park. E. H. Moss 7257, Aug. 22, 1946.

Agropyron violaceum (Hornem.) Lange. Reported by Porsild (1959).
Sunwapta Pass, Jasper National Park. E. H. Moss 10956, Aug. 31, 1957.

Agrostis humilis Vasey. Reported by Porsild (1959).

Poa lanata Scribn. & Merr. Reported by Porsild (1959).

Poa lettermani Vasey. Reported by Porsild (1959).
Whistler Mt., Jasper National Park. J. G. Packer 3426.2, July 27, 1965.

CYPERACEAE

Carex glacialis Mack. Reported by Porsild (1959).

Carex misandra R. Br. Reported by Boivin (1967).
Prospect Mt., Cadomin. J. G. Packer 71-135, July 7, 1971.
Cheviot Mt., Cadomin. M. G. Dumais 5632, July 8, 1971.

Carex supina Willd. Reported by Boivin (1967).

Eleocharis elliptica Kunth. Reported by Moss & Pegg (1963).

Eriophorum callitrix Cham. Reported by Boivin (1967).
Whistler Mt., Jasper National Park. J. G. Packer 3419.2, July 27, 1965.
Cadomin. G. Pegg 2359, July 9, 1966.
Cardinal Divide, Cadomin. M. G. Dumais 5164, July 7, 1970.

Rhynchospora capillacea Torr. Reported by Moss & Pegg (1963).

JUNCACEAE

Juncus stygius L. Reported by Moss & Pegg (1963).

Luzula acuminata Raf.
Swan Hills. G. Pegg 1057, June 25, 1961.

Luzula arcuata (Wahlenb.) Sw.
Mt. Edith Cavell, Jasper National Park. J. G. Packer. Aug. 15, 1958.
Cadomin. G. Pegg 2484, Aug. 11, 1966.
Signal Mt., Jasper National Park. J. Hrapko 67-364, July 17, 1967.
Cardinal Divide, Cadomin. M. G. Dumais 5151, July 7, 1970.

LILIACEAE

Streptopus streptopoides (Ledeb.) F. & R. Reported by Moss & Pegg (1963).

Tofieldia coccinea Rich. Reported by Boivin (1967).

SALICACEAE

Populus × *bernardii* Boivin. Reported by Boivin (1966).
P. tremuloides × *P. deltoides* var. *occidentalis.*

Populus × *dutillyi* Lepage. Reported by Boivin (1966).
P. tremuloides × *P. balsamifera* var. *subcordata.*

Populus × *jackii* Sarg. Reported by Boivin (1966).
P. balsamifera × *P. deltoides* var. *occidentalis.*

Populus × *sennii* Boivin. Reported by Boivin (1967).
P. angustifolia × *P. tremuloides.*

Salix reticulata L. Reported by Porsild (1959).
Prospect Mt., Cadomin. J. G. Packer 71-124, July 7, 1971.
No Name Creek, N. Nordegg. M. G. Dumais 5686, July 9, 1971.

BETULACEAE

Betula resinifera Britt. Reported by Dugle (1966).
Cold Lake. J. Dugle 1579, July 16, 1961.
5 mi NE of Beaver Lake (Lac La Biche). J. Dugle 1530, July 14, 1961.
93 mi. N of Whitecourt. J. Dugle 1423, June 25, 1961.

Betula × *arbuscula* Dugle. Reported by Dugle (1966).
B. papyrifera × *B.* × *sargentii*
Mt. Edith Cavell, Jasper National Park. J. Dugle 2256, Aug. 28, 1962.
East entrance to Jasper National Park. J. Dugle 1767, Sept. 7, 1961.
Maligne Canyon, Jasper. J. Dugle 1746, Sept. 6, 1961.

Betula × *eastwoodae* Sargent. Reported by Dugle (1966).
B. fontinalis × *B. glandulosa*
Jasper House Historical Marker, Jasper National Park, J. Dugle 1921. June 22, 1962.
Pyramid Lake, Jasper National Park. J. Dugle 2251, Aug. 28, 1962.
Banff, Banff National Park. J. Dugle 2064, June 25, 1962.

Betula × *sandbergii* Britt. Reported by Dugle (1966).
B. papyrifera × *B. glandulifera*
Whitemud Park, Edmonton. J. Dugle, June 14, 1962.
Elk Island National Park. J. Dugle 2095, July 11, 1962.

Betula × *sargentii* Dugle. Reported by Dugle (1966).
B. glandulosa × *B. glandulifera*
Near Leslieville. J. Dugle 1318, June 2, 1961.
Near Rocky Mountain House, J. Dugle 1328, June 2, 1961.
Near Edson. J. Dugle 1720, Sept. 4, 1961.
Pyramid Lake, Jasper National Park, J. Dugle 1752, Sept. 5, 1961.

Betula × *uliginosa* Dugle. Reported by Dugle (1966).
B. glandulifera × *B. resinifera*
Ponoka, c. 60 mi. S. of Edmonton. J. Dugle 1691, Aug. 13, 1961.
Near Wizard Lake, NE of Pigeon Lake, J. Dugle 1300, June 1, 1961.

B. × *utahensis Britt.* Reported by Dugle (1966).
B. papyrifera × *B. fontinalis*
Celestine Lake, Jasper National Park. J. Dugle 1929, June 22, 1962.

Betula × *winteri* Dugle. Reported by Dugle (1966).
B. papyrifera × *B. resinifera*
North Saskatchewan River bluffs near Edmonton. J. Dugle 1381, June 21, 1961.
Hilltop near Muir Lake. J. Dugle 1596, July 31, 1961.
Elk Island National Park. J. Dugle 2083, July 11, 1962.

POLYGONACEAE

Rumex orbiculatus Gray. Reported by Boivin (1966).
Glenevis. G. Pegg 4117-4270, June 21, Aug. 8, 1971.

CARYOPHYLLACEAE

Arenaria humifusa Wahl. Reported by Porsild (1959).
Cerastium alpinum L. Reported by Boivin (1966).

NYCTAGINACEAE

Abronia micrantha Torrey. Reported by Bovin (1966).

RANUNCULACEAE

Ranunculus gelidus Kar. & Kir. Reported by Benson (1948).
Whistler Mt., Jasper National Park. J. G. Packer 3446.2, July 27, 1965.

Ranunculus nivalis L.
Persimmon Range, Willmore Wilderness Park. J. G. Packer 304, July 23, 1965.
Signal Mt., Jasper National Park. J. Hrapko 67-45, June 24, 1967.

PAPAVERACEAE

Papaver freedmanianum D. Löve
Opal Hills, Jasper National Park. P. Kuchar 210, July 17, 1968.

CRUCIFERAE

Braya purpurascens (R. Br.) Bunge
Persimmon Range, Willmore Wilderness Park. J. G. Packer 3381, July 25, 1965.
Cardinal Divide, Cadomin. M. G. Dumais 2376, June 15, 1968.
Cheviot Mt., Cadomin. J. G. Packer 71-129, July 7, 1971.

Draba borealis DC. Reported by Mulligan (1970).
Columbia Icefield, Jasper National Park. H. J. Scoggan 15002, June 22, 1964.
Whistler Mt., Jasper National Park. J. G. Packer 5196, July 5, 1967.
Cheviot Mt., Cadomin. M. G. Dumais, July 8, 1971.

Draba cinerea Adams. Reported by Porsild (1959).
Draba densifolia Nutt. Reported by Porsild (1959).
Draba glabella Pursh. Reported by Mulligan (1970).
Persimmon Range, Willmore Wilderness Park, J. G. Packer 3293, July 22, 1965.
Mountain Park, Cadomin. J. G. Packer 2726, June 12, 1965.
Signal Mt., Jasper National Park. J. G. Packer 5112, June 20, 1967.

Draba kananaskis G. A. Mulligan. Reported by G. A. Mulligan (1970).

Draba reptans (Lam.) Fern. Reported by Bovin (1966).
Macleod. R. H. Dixon 961, April 22, 1934.

Draba ventosa A. Gray. Reported by Porsild (1959).
Highwood Pass, Kananaskis. P. Seymour, Aug. 15, 1956.
Persimmon Range, Willmore Wilderness Park. J. G. Packer 3276, July 22, 1965.
Highwood Pass, Kananaskis. J. G. Packer 69-442a, Aug. 8, 1969.

DROSERACEAE

Drosera linearis Goldie. Reported by Boivin (1966).
Crimson Lake. M. Ostafichuk 304A, July 21, 1968.

SAXIFRAGACEAE

Chrysosplenium tetrandrum (Lund.) Fries. Reported by Packer (1963).
Nordegg, Clearwater Forest Reserve. R. G. H. Cormack 802, Sept. 1, 1945.
Meander River, Mackenzie Highway. Moss 8810, July 10, 1949.
Mountain Park, Cadomin, J. G. Packer 2729, June 12, 1965.
Cold Lake, M. G. Dumais 1318, June 21, 1967.

Conimitella williamsii (D. C. Eat.) Rydb. Reported by Boivin (1966).

Heuchera glabra Willd. Reported by Ogilvie (1962).
Lake Edith Cavell, Jasper National Park. J. G. Packer, Aug. 4, 1958.

Saxifraga flagellaris Willd. s.l. Reported by Porsild (1959).
Eagle Nest Creek, Willmore Wilderness Park. G. Pegg 1727, Aug. 3, 1964.

ROSACEAE

Potentilla hyparctica Malte. Reported by Porsild (1959).
Persimmon Range, Willmore Wilderness Park. J. G. Packer 3304, July 23, 1965.
Whistler Mt., Jasper National Park. J. G. Packer 3453.2, July 27, 1965.
Highwood Pass, Kananaskis. J. G. Packer 3894, July 22, 1966.
Signal Mt., Jasper National Park. J. Hrapko 67-107, July 3, 1967.
Cardinal Divide, Cadomin. M. G. Dumais 5153b, July 7, 1970.

Potentilla ovina J. Macoun. Reported by Porsild (1959).
Whisky Gap. E. H. Moss 1147, May 17, 1941.
Waterton Lakes National Park, Sofa Mt., A. J. Breitung 17218, Aug. 6, 1953.
Highwood Pass, Kananaskis. J. G. Packer 69-420b, Aug. 9, 1969.
Cheviot Mt., Cadomin. J. G. Packer 71-113, July 7, 1971.
M. G. Dumais 5605a, July 7, 1971.

Potentilla villosa Pall. Reported by Ogilvie (1962).
Whistler Mt., Jasper National Park, J. G. Packer 5187, July 5, 1967.
Signal Mt., Jasper National Park. J. Hrapko, 68-9, July 3, 1968.

Potentilla yukonensis Hultén. Reported by Boivin (1966).
Fort Vermilion. B. Boivin and J. M. Perron 12600. July 21, 1958.

LEGUMINOSAE

Lupinus lepidus Dougl. Reported by Ogilvie (1962).

Lupinus nootkatensis Donn Reported by Ogilvie (1962).
Persimmon Range, Willmore Wilderness Park. J. G. Packer 3230, July 22, 1965.

Lupinus polyphyllus Lindl. Reported by Boivin (1966).

Lupinus wyethii S. Wats. Reported by Dunn & Gillett (1966).

Oxytropis lagopus Nutt. Reported by Boivin (1966).

GERANIACEAE

Geranium erianthum DC. Reported by Boivin (1966).

POLYGALACEAE

Polygala paucifolia Willd.
20 mi. N. of Fort McMurray. M. G. Dumais 2554, June 21, 1968.

VIOLACEAE

Viola blanda Willd. Reported by Boivin (1966).

Viola pallens (Banks) Brainerd. Reported by Boivin (1966).

UMBELLIFERAE

Lomatium coüs (Watson) C. & R.
Reesor Lake, Cypress Hills. P. J. Scott 1135, May 9, 1971.

Lomatium columbianum Math. Reported by Porsild (1959).

ERICACEAE

Loiseleuria procumbens (L.) Desf.
Tonquin Valley, Jasper National Park. J. G. Packer, Aug. 15, 1958.
N. B. Sanson (undated)

BORAGINACEAE

Cryptantha minima Rydb. Reported by Boivin (1966).

Cynoglossum officinale Fern. Reported by Moss & Pegg (1963).

SCROPHULARIACEAE

Pedicularis albertae Hultén. Reported by Hultén (1961).
Persimmon Range, Willmore Wilderness Park. J. G. Packer 3288, July 22, 1965.

Rhinanthus groenlandicus Chab. Reported by Porsild (1959).

LENTIBULARIACEAE

Utricularia cornuta Michx.
10 mi. S. Richardson Lake. M. Stick 15. July 1971.

PLANTAGINACEAE

Plantago maritima L. Reported by Boivin (1966).

RUBIACEAE

Galium palustre L. Reported by Moss & Pegg (1963).
Patricia Lake, Jasper National Park. J. G. Packer 60-101, Aug. 22, 1960.

LOBELIACEAE

Lobelia spicata Lam. Reported by Boivin (1966).

COMPOSITAE

Agoseris grandiflora (Nutt.) Greene. Reported by Boivin (1966).

Antennaria acuta Rydb. Reported by Boivin (1966).

Antennaria angustata Greene. Reported by Porsild (1965).

Antennaria glabrata (J. Vahl.) Greene. Reported by Porsild (1965).

Antennaria monocephala DC. Reported by Boivin (1966).

Antennaria neodioica Greene. Reported by Boivin (1966).

Antennaria ungavensis (Fern.) Malte. Reported by Porsild (1965).

Artemisia borealis Pall.
Mountain Park, Cadomin. J. G. Packer 3066, July 4, 1965.

Artemisia tilesii Ledeb.
Salt Plains, Wood Buffalo Park J. G. Packer & M. G. Dumais 259, Sept. 2, 1970.

Aster mccallae Rydb. Reported by Porsild (1959).

Erigeron evermannii Rydb. Reported by Boivin (1966).

Erigeron uncialis Blake. Reported by Porsild (1959).

Microseris cuspidata (Pursh) Schultz-Bip. Reported by Boivin (1966).

Prenanthes alata (Hook.) Dietr. Reported by Moss & Pegg (1963) as *P. sagittata* (A. Gray) A. Nels.
Goose Mt., Swan Hills. E. H. Moss 12474, Aug. 8, 1961.

Senecio foetidus Howell. Reported by Boivin (1966).

Thelespermia marginatum Rydb. Reported by Rydberg (1900).

Townsendia condensata D. C. Eaton
Waterton Lakes National Park, Horseshoe Basin. J. Kuijt 3533, June 19, 1970.

Townsendia hookeri Beaman. Reported by Beaman (1957).
Waterton Lakes National Park, north entrance. A. J. Breitung 17067, Aug. 4, 1953.

Introduced Species

The majority of these species have been previously reported for the province mostly by Boivin (1966). some by Moss & Pegg (1963), but *Rumex confertus, Rumex longifolius, Chamaesaracha grandiflora* and *Lapsana communis* have not been reported before.

POLYGONACEAE
Rumex confertus Willd.
Rumex dentatus L.
Rumex fennicus Murb.
Rumex longifolius DC.

CARYOPHYLLACEAE
Dianthus barbatus L.
Dianthus sylvestris Wulfen
Gypsophila acutifolia Fischer
Scleranthus annuus L.
Silene conoidea L.

CRUCIFERAE
Rorippa nasturtium-aquaticum (L). Hayek

CRASSULACEAE
Sedum acre L.
Sedum aizoon L.
Sedum hybridum L.

OXALIDACEAE
Oxalis corniculata L.

UMBELLIFERAE
Anethum graveolens L.
Eryngium planum L.

HYDROPHYLLACEAE
Phacelia campanularia Gray

BORAGINACEAE
Myosotis laxa Lehm.

LABIATAE
Galeopsis speciosa Mill.

SOLANACEAE
Chamaesaracha grandiflora (Hooker) Fern.
Solanum rostratum Dunal

SCROPHULARIACEAE
Odontites serotina (Lam.) Dum.
Verbascum nigrum L.
Verbascum phlomoides L.

PLANTAGINACEAE
Plantago aristata Michx.

COMPOSITAE
Arctium nemerosum Lej. & Court.
Artemisia abrotanum L.
Centaurea cyanus L.
Centaurea diffusa Lam.
Galinsoga ciliata (Raf.) Blake
Cichorium endiva L.
Lapsana communis L.
Picris echioides L.
Saussurea glomerata Poiret
Tragopogon porrifolius L.
Tragopogon pratensis L.

Finally it should be mentioned that a number of species have been found that Moss included in his flora "as reported for Alberta" or "expected in Alberta", though without having seen material. Confirmation of the occurrence in Alberta of the following species has been obtained.

Festuca viridula Vasey
Rock Lake, Willmore Wilderness Park. J. G. Packer 3178, July 21, 1965.

Hierochloe alpina (Sw) R. & S.
Signal Mt., Jasper National Park. J. G. Packer 5108, June 20, 1967.

Carex pyrenaica Wahl.
Bald Hills, Jasper National Park. P. Kuchar, Sept. 7, 1971.

Juncus biglumis L.
Mt. Edith Cavell, Jasper National Park, J. G. Packer 6076, Aug. 18, 1960.
Sunwapta Pass, Jasper National Park. J. A. Calder & K. T. Mackay 32692, Aug. 1, 1961.
Whistler Mt., Jasper National Park. J. G. Packer 3425.2, July 27, 1965.

Koenigia islandica L.
Edith Cavell Lake, Jasper National Park. J. G. Packer 60-134. Aug. 24, 1960.
Whistler Mt., Jasper National Park. J. G. Packer 3418.2, July 27, 1965.

Arenaria serpyllifolia L.
Dardanelles, Waterton Lakes National Park. P. W. Stringer, June 26, 1968.

Melandrium affine (J. Vahl.) Hartm.
Kananaskis Forestry Road. J. G. Packer 1969-447, Aug. 9, 1969.

Cardamine bellidifolia L.
Mt. Edith Cavell, Jasper National Park. J. G. Packer, Aug. 5, 1958.
Whistler Mt., Jasper National Park. J. G. Packer 3447.2, July 27, 1965.
Parker Ridge, Columbia Icefield. M. G. Dumais 5753, Aug. 2, 1971.

Erysimum pallasii (Pursh) Fern.
Whistler Mt., Jasper National Park. J. G. Packer 3440, July 27, 1965.
Bald Hills, Jasper National Park. P. Kuchar, May 29, 1971.

Epilobium luteum Pursh
Banff National Park. H. J. Scoggan 16478, Aug. 21, 1964.

Pedicularis flammea L.
Cardinal Divide, Cadomin. P. Seymour, July 11, 1964.
Persimmon Range, Willmore Wilderness Park. J. G. Packer 3383, July 23, 1965.
Cardinal Divide, Mountain Park. M. G. Dumais 4230, Aug. 13, 1968.
Cheviot Mt., Cadomin. M. G. Dumais 5603, July 8, 1971.

Erigeron pallens Cronq.
Parker Ridge, Columbia Icefield. M. G. Dumais 5731. Aug. 2, 1971.

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Insular Fishes of Iles de la Madéleine, Gulf of St. Lawrence, Canada

E. T. Garside, J. M. Snair and D. L. Waugh

Department of Biology
Dalhousie University
Halifax, Nova Scotia

Résumé. Quatorze espèces des poissons marins et euryhalines ont été recueilli diversement de 13 places sur l'archipel des Îles de la Madéleine au Golfe St. Laurent. Pas des poissons stenohalines de l'eau douce ont été recueilli de quelques étangs et des petites rivières. Notamment il y a été l'événement singulier de le petit barré *Fundulus diaphanus,* dans un étang de l'eau douce et l'événement de l'épinoche tachetee *Gasterosteus wheatlandi* dans le même étang. Les autres espèces recueillis ont été, *Alosa pseudoharengus* (Clupeidae); *Fundulus heteroclitus* (Cyprinodontidae); *Gasterosteus aculeatus, Pungitius pungitius, Apeltes quadracus* (Gasterosteidae); *Menidia menidia* (Atherinidae); *Tautogolabrus adspersus* (Labridae); *Artediellus uncinatus, Myoxocephalus scorpius, M. octodecemspinosus* (Cottidae); *Pseudopleuronectes americanus* et *Scophthalmus aquosus* (Pleuronectidae).

Abstract. Fourteen species of euryhaline and marine fishes were collected variously from 13 collecting sites on the connected series of Îles de la Madéleine in the Gulf of St. Lawrence. No stenohaline freshwater fishes were collected from the few inland ponds and small streams. Of particular note were the singular occurrence of the banded killfish *Fundulus diaphanus,* in a freshwater pond and the occurrence of the blackspotted stickleback *Gasterosteus wheatlandi* in the same pond. The other species were, *Alosa pseudoharengus* (Clupeidae); *Fundulus heteroclitus* (Cyprinodontidae); *Gasterosteus aculeatus; Pungitius pungitius, Apeltes quadracus* (Gasterosteidae); *Menidia menidia* (Atherinidae); *Tautogolabrus adspersus* (Labridae); *Artediellus uncinatus, Myoxocephalus scorpius, M. octodecemspinosus* (Cottidae); *Pseudopleuronectes americanus* and *Scophthalmus aquosus* (Pleuronectidae).

Introduction

Previous surveys of the piscifauna of the Gulf of St. Lawrence which have included Iles de la Madéleine have been reported by Cox (1921) and by Bergeron and Legendre (MS 1970). These islands are situated near 61° 30′W, 47°30′N in the southern region of the Gulf, approximately 80 km north of the northeast point of Prince Edward Island. They constitute an archipelago of 12 islands, seven of which are linked by barrier beaches and causeways (Fig. 1). These barriers have created two elongate lagoons, the northern one of which has been divided by a causeway. Numerous smaller barrachois are situated along low shoreline. The three major islands of the southern part of this chain, Ile de Havre-Aubert, Ile de Cap-aux-Meules and Ile de Havre-aux-Maisons, have significant elevations and fluvial drainages. These channels are narrow, generally steeply graded and, at the time of the present survey, conducted only small discharges. Ile de Havre-Aubert has a freshwater lake, Etang des Caps, which was inaccessible.

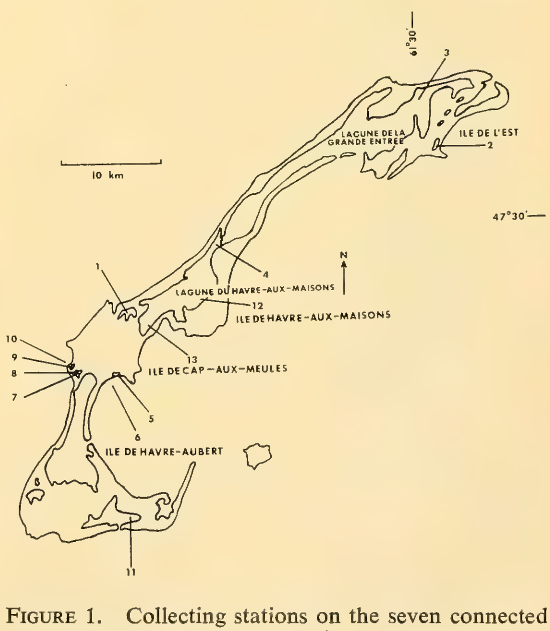

Figure 1. Collecting stations on the seven connected islands of the archipelago, Îles de la Madéleine, Gulf of St. Lawrence.

[1]Identification confirmed by Dr. W. B. Scott. Royal Ontario Museum, Toronto.

Ile de Cap-aux-Meules has an unnamed freshwater pond north of the community of Fatima.

This survey was conducted on the main body of islands, from May 30 to June 5, 1969. Fish were collected at 13 stations (Fig. 1) by seining or in a gang of gillnets of graded mesh-sizes ranging from 25 to 100mm. Since no fish were located in any of the streams, no stations have been designated along these channels. All samples were preserved unless noted in the text, and stored in the Department of Biology, Dalhousie University.

Collections

Fourteen species were collected, 12 by netting and two by angling. They are classified among 11 genera, seven families and five orders in the system employed by Leim and Scott (1966). The species, in order of decreasing prevalence with the number of occurrences indicated in parentheses, are,

Fundulus heteroclitus (Linnaeus), mummichog (10)
Gasterosteus aculeatus Linnaeus, threespine stickleback (9)
Gasterosteus wheatlandi Putnam, black-spotted stickleback (9)
Pungitius pungitius (Linnaeus), ninespine stickleback (9)
Pseudopleuronectes americanus (Walbaum), winter flounder (8)
Menidia menidia (Linnaeus), Atlantic silverside (5)
Apeltes quadracus (Mitchill), fourspine stickleback (4)
Alosa pseudoharengus (Wilson), alewife (2)*
Myoxocephalus scorpius (Linnaeus), shorthorn sculpin (2)
Fundulus diaphanus (Lesueur), banded killfish (1)[1]
Scophthalmus aquosus (Mitchill), windowpane (1)
Artediellus uncinatus (Reinhardt), Arctic hookear sculpin (1)
Myoxocephalus octodecemspinosus (Mitchill), longhorn sculpin (1)
Tautogolabrus adspersus (Walbaum), cunner (1)*

Locations and descriptions of sampling stations are listed together with species in the samples.

No. 1. Pond, northeast of Fatima. Surface water is fresh; deeper water was not examined. No fish were collected in an overnight set of gillnets. Six species were collected by seining.

Fundulus diaphanus
Fundulus heteroclitus
Gasterosteus wheatlandi
Gasterosteus aculeatus
Apeltes quadracus
Pungitius pungitius

No. 2. Barrachois, Plage de la Grande Echouerie at Old Harry. Water was strongly brackish. Only one species collected.

Pungitius pungitius

No. 3. Inner beach, Lagune de la Grande Entrée near Pont de Grosse Ile. Four species were collected by seining.

Fundulus heteroclitus
Gasterosteus wheatlandi
Artediellus uncinatus
Pseudopleuronectes americanus

No. 4. Beach, Langune du Havre-aux-Maisons, at south end of causeway. Six species were collected by seining.

Alosa pseudoharengus
Gasterosteus wheatlandi
Apeltes quadracus
Pungitius pungitius
Myoxocephalus scorpius
Pseudopleuronectes americanus

No. 5. Barrachois on Baie de Plaisance, 1.5 km west of Cap Rouge. The basin was sand and the water was strongly brackish. Seining yielded six species.

Fundulus heteroclitus
Gasterosteus aculeatus
Gasterosteus wheatlandi
Menidia menidia
Pseudopleuronectes americanus
Scophthalmus aquosus

No. 6. Beach, Baie de Plaisance, 2km west of Cap Rouge. Six species were collected by seining.

Fundulus heteroclitus
Gasterosteus wheatlandi
Gasterosteus aculeatus
Pungitius pungitius
Menidia menidia
Pseudopleuronectes americanus

No. 7. Etang du Sud, southwest coast of Ile de Cap-aux-Meules. A brackish tidal pond which drains by a channel to the Gulf. Eight species were collected, six by seining and two in gillnets (*).

*Alosa pseudoharengus**
Fundulus heteroclitus
Gasterosteus wheatlandi

*not retained

Gasterosteus aculeatus
Apeltes quadracus
Pungitius pungitius
Menidia menidia
*Pseudopleuronectes americanus**

No. 8. Barrachois, 100m west of Etang du Sud, Ile de Cap-aux-Meules. Four species were collected by seining.

Fundulus heteroclitus
Menidia menidia
Gasterosteus aculeatus
Pungitius pungitius

No. 9. Pond, 300m east of Cap Brillant, Ile de Cap-aux-Meules. Four species were collected by seining.

Fundulus heteroclitus
Gasterosteus wheatlandi
Gasterosteus aculeatus
Pungitius pungitius

No. 10. Beach, Cap Brillant, Ile de Cap-aux-Meules. Two species were collected.

Myoxocephalus scorpius
Pseudopleuronectes americanus

No. 11. Beach, east end of Le Bassin, Ile de Havre-Aubert. This lagoon opens by a broad gap to the Gulf. Seining yielded five species.

Fundulus heteroclitus
Gasterosteus wheatlandi
Gasterosteus aculeatus
Menidia menidia
Pseudopleuronectes americanus

No. 12. Beach, Lagune du Havre-aux-Maisons, 0.5km north of Le Pre. Six species were collected by seining.

Fundulus heteroclitus
Gasterosteus wheatlandi
Gasterosteus aculeatus
Apeltes quadracus
Pungitius pungitius
Pseudopleuronectes americanus

No. 13. Barrachois, 0.5km south of Pont du Havre-aux-Maisons, west side of Chemin principal. Three species were collected.

Fundulus heteroclitus
Gasterosteus aculeatus
Pungitius pungitius

An incidental collection, by angling, at Pont de la Pointe de l'Est, Havre de la Grande Entrée, added two more species, *Myoxocephalus octodecemspinosus* and *Tautogolabrus adspersus*.

Discussion

This survey of the insular fishes of the main series of Iles de la Madéleine is more extensive than either of the previous surveys. Cox (1921) listed some species by reports rather than collections, and did not cite exact locations for those that were collected. The more recent collections of Bergeron and Legendre (MS 1970) are given with precise locations, but some of their stations were offshore and on the smaller islands remote from the connected series.

There is considerable duplication in the lists of species for the three surveys, but some of those reported here were not reported in the earlier studies of the same waters. Alewife and shorthorn sculpin were not reported by Cox (1921) and alewife, Arctic hookear sculpin, longhorn sculpin, shorthorn sculpin and winter flounder were not reported by Bergeron and Legendre (MS 1970).

Two species in the present study warrant further comment. The isolated occurrence of the banded killifish on these islands was first recorded by Bergeron (personal communication) following a correction in identification of a 1950 sample of fundulids from a small pond or barrachois along the Chemin principal near the Pont du Havre-aux-Maisons, apparently corresponding to Station No. 13 in this study. Bergeron also reports that killifish collected in 1955 in Lagune du Havre-aux-Basques and identified as *Fundulus majalis* were actually *F. diaphanus*. Unfortunately, the collection has been lost. However, after examining specimens of *F. majalis* from Massachusetts, we conclude that a confusion between *F. majalis* and *F. heteroclitus* is more probable than that between *F. majalis* and *F. diaphanus*. Also, an even greater probability exists for confusion between *F. heteroclitus* and *F. diaphanus*. The pond from which we collected these banded killifish has a sand basin and appears rather similar to typical barrachois of these islands except that the pond has fresh water at least at the surface. We were unable to determine whether there was any residue of saline water in the deepest part of the pond. Also, the pond is considerably more remote from the water

of the Gulf than are typical barrachois, being at least 300m from the closest shore. Presumably then, the pond is a long-established barrachois and the fish have been established there since the pond became closed from the Gulf. The banded killifish is generally considered to be a freshwater species although its relative tolerance to sea water has been established experimentally (Garside and Jordan 1968). This species has not been reported in the open water of the Gulf but the simplest explanation of their presence in this pond is that they swam there from some previously established population and entered while the barrier was breached. This explanation of extended movement in salt water has been offered for the advent of this species in the coastal water of St. George's Bay, southwest Newfoundland (Leim and Scott 1966) and an even greater distance is involved.

The blackspotted stickleback was collected by us from the same pond as the banded killifish but was not reported from fresh water of Iles de la Madéleine by Bergeron and Legendre (MS 1970). The first record of this species occurring in fresh water is that of McAllister (1960). He collected one specimen above the tidal limit in the Jacquet River, New Brunswick. However, that individual had ready access to salt water while those in our collection were confined. The original occurrence of this species in this pond poses no problem of interpretation if the pond is in fact a barrachois behind an advancing barrier. However, the subsequent success of these fish in a pond which has become essentially a body of fresh water indicates that they are more tolerant of low salinity than has hitherto been realized. In connection with other studies, we have maintained blackspotted sticklebacks in fresh water in the laboratory, for essentially an infinite period. By analogy with the *leiurus* form of threespine sticklebacks, blackspotted sticklebacks because they also have a low number of lateral plates might well be expected to occur most commonly in fresh water as do those threespine sticklebacks with a low number of plates (Münzing 1963; Hagen 1967). Perhaps then, their habitual occurrence in strongly brackish water may not be an avoidance of fresh water *per se* but may be the more direct result of some other avoidance, or a requirement associated with marine littoral habitats.

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Additions to the Avifauna of St. Pierre and Miquelon

LESLIE M. TUCK[1] AND MICHEL J. BOROTRA[2]

[1]Canadian Wildlife Service, St. John's, Newfoundland.
[2]Service de l'Elevage et des Industries animales, BP 304, St. Pierre et Miquelon (via North Sydney).

Abstract. The French Overseas Territory of St. Pierre et Miquelon is 10 miles off the south coast of Newfoundland. This paper adds 67 new species, for a total of 185 now recorded, to the archipelago. Many of these new records are drift-migrants from the southwest or strays from the northeast. Among the anomalies are the breeding of Red-throated Loon, absent from the island of Newfoundland, and the absence of Gray Jays which are relatively common in Newfoundland. The only species recorded in the archipelago but not from Newfoundland is the Whistling Swan.

The archipelago of St. Pierre et Miquelon is situated in the northwest Atlantic at approximately 46°N;56°W. It is a French Overseas Territory consisting of three major islands, St. Pierre, Miquelon and Langlade (formerly Little Miquelon) and 9 or 10 small islets. Geographically, the archipelago of Cambrian and Pre-Cambrian origin is similar to the nearby Burin Peninsula of Newfoundland (from which it is separated by 10 miles) and has a human population of about 6,000 of whom most (5,000) reside in the town of St. Pierre.

At one time heavily wooded in places, according to historical records, the only sizeable stands of timber are now restricted to the river valley in Langlade. Much of the land is now heathland and rather bleak with rocky outcrops and small bogs and ponds similar to the nearby southern portion of the island of Newfoundland. Exceptions are the seven-miles of sand dunes which for the past 200 years have connected Miquelon to Langlade. These dunes have stabilized and are increasing in size. Tradition has it that formation and eventual stabilization were caused by the frequent shipwrecks in the locality in the 16th and 17th centuries. Another important biotope is the Grand Barachois of some 20 square miles at the northern end of the Dunes. It is a favourite area for Grey Seals, *Halichoerus grypus,* and for migrating waterfowl and shorebirds. High cliffs on Langlade and on the smaller islets are nesting sites for cormorants (both species), alcids (Common Murres, puffins, Razorbills and Black Guillemots), Kittiwakes, Herring and Great Black-backed gulls. Leach's Petrels breed on islets covered with turf, especially Colombier.

Only two ornithological papers have been written on this archipelago, by Peters and Burleigh (1951) and by Cameron (1967). Together, they reported on 118 species. This paper adds 67 species to the recorded avifauna of the locality, as well as pertinent notes on a few others. Most of the records are those of the junior author (MJB) whose interest in ornithology has been long, and who during the past five or six years, has kept up a steady correspondence with LMT and forwarded specimens for confirmation of identity. Another important contribution to this paper has been made by the Musée de St. Pierre, which is gradually acquiring a collection of mounted specimens of birds collected in the archipelago. In this regard and for additional information, we are indebted to Norbert Bouget, Guy Comier, A. L. Detcheverry, Leon Gaspard, Pierre Lapaix, George Ozon, and Michel Poirier.

The most striking difference between the avifauna of the archipelago and the nearby island of Newfoundland is the breeding of the Red-throated Loon, *Gavia stellata,* on Miquelon and Langlade but not in Newfoundland. Cameron (1967) attributes this to the relative scarcity of mammalian predators in the archipelago. The Red Fox, *Vulpes vulpes,* is the only terrestrial carnivore, apart from domestic dogs and cats, and even it is scarce. The rookeries of Common Cormorants, *Phalacrocorax carbo,* are the most easterly in North America. In Newfoundland, they breed only on the southwest coast. Other anomalies are the virtual absence of Crows, *Corvus brachyrhynchos,* and Gray Jays, *Perisoreus canadensis,* both of which

are relatively common in nearby Newfoundland.

The islands of St. Pierre and Miquelon are now of considerable interest to tourists. The charm of its Old World traditions and customs have been recently made easily accessible by transportation from Sydney, Nova Scotia, or Fortune, Newfoundland. Undoubtedly, among future visitors will be some who are interested in the ornithology of the archipelago. It is still imperfectly known. The present paper brings the total species recorded to 185 species. It should be used in conjunction with Cameron (1967). The totals will increase particularly because of its favourable location for drift-migrants and hurricane-borne stragglers. The bird-lists of interested visitors will be appreciated by the junior author who plans to write a more definitive account.

Annotated List

*RED-NECKED GREBE (*Podiceps grisegena*). — This species occurs fairly regularly each winter, usually solitary but as many as four together. Extreme winter dates are September 28, 1967 to February 7, 1965 on Miquelon. In addition, two spring observations of single birds were made at St. Pierre on April 4, 1967 and April 23, 1965. A single summer observation was made on July 3, 1967 on Langlade. Similarly in Newfoundland this species occurs occasionally in the spring and more frequently in the winter.

PIED-BILLED GREBE (*Podilymbus podiceps*). — Cameron (1967) records a specimen on September 22, 1964 at Grand Barachois. In addition, two were observed on October 3, 1966 and one shot on September 3, 1971 also at Grand Barachois.

*FULMAR (*Fulmarus glacialis*). — This species was not recorded by Peters and Burleigh (1951) or Cameron (1967) yet Fulmars from West Greenland and the British Isles occur regularly on the St. Pierre and nearby fishing banks (Tuck, 1971). Fulmars can often be seen in the channel separating St. Pierre from Langlade at any time during the year.

*SOOTY SHEARWATER (*Puffinus griseus*). — This species occurs regularly off St. Pierre and Miquelon in company with the more abundant Greater Shearwater (*Puffinus gravis*). It arrives on the Grand Banks in early March (Tuck, 1967). On July 16, 1966 approximately 100 Sooty Shearwaters and 2,500 Greater Shearwaters were recorded off the southeast coast of Miquelon. The latest date for Sooty Shearwaters in the area is September 10, 1967 and the latest date for Greater Shearwaters is October 16, 1971.

*MANX SHEARWATER (*Puffinus puffinus*). — Recoveries off Newfoundland of Manx Shearwaters banded in Skokholm, Wales, indicate that this species is more abundant in this sector of the North Atlantic, particularly in the summer months, than the published observations indicate (Tuck, 1971). On July 9, 1968, during a very stormy day a single bird was captured at St. Pierre and brought to MJB who released it two hours later, whereupon it flew away strongly.

*WILSON'S PETREL (*Oceanites oceanicus*). — This species is fairly common in summer on nearby St. Pierre fishing banks. Of 150 petrels marooned in the harbour of St. Pierre on a stormy July 26, 1969 approximately one-third of those were identified at close range and were positively this species (MJB).

*GREAT BLUE HERON (*Ardea herodias*). — This large and distinctive heron occurs occasionally in the archipelago, always singly and most frequently in the spring. The earliest record is on April 12, 1966 and the latest November 30, 1965. Most spring records are in June. One was recorded on July 22, 1965. Specimens of an adult male and an immature collected in St. Pierre are in the Musée de St. Pierre.

*GREEN HERON (*Butorides virescens*). — Three specimens have recently been recorded. On November 11, 1964 an adult male and in September, 1969 an immature were shot in Miquelon. Both were donated to the Musée. Another adult male, found dead on August 30, 1970 was brought to MJB but was in too poor condition to preserve.

*LITTLE BLUE HERON (*Florida caerulea*). — On June 30, 1965 MJB photographed an immature bird of this species in a small brook east of Miquelon.

SNOWY EGRET (*Leucophoyx thula*). — An adult found dead at Ravenal, near the west end of St. Pierre Island on May 1, 1964 by MJB was photographed and pertinent feathers salvaged (Cameron, 1967). An adult was shot on May 4, 1970 and donated to the Musée. An immature, identified by MJB, was shot on Miquelon on October 16, 1971.

*COMMON EGRET (*Casmerodius albus*). — An adult shot in St. Pierre in April, 1924 was mounted by a local resident. It has since disintegrated but a few feathers were salvaged for the record.

*BLACK-CROWNED NIGHT HERON (*Nycticorax nycticorax*). — A flight of this species into the archipelago occurred on May 24, 1971 and the birds were noted until April 5. An adult male was collected on March 27 for the Musée and two others shot about the same time. An extensive flight of possibly drift-migrants also reached Newfoundland at the same time.

*YELLOW-CROWNED NIGHT HERON (*Nyctanassa violacea*). — An immature was shot in St. Pierre on August 28, 1965 and presented to the Musée. MJB

* denotes new addition

photographed another immature in St. Pierre on October 22, 1966. An adult male was found dead at Galantry lighthouse on February 12, 1971.

*LEAST BITTERN (*Ixobrychus exilis*). — An adult male was shot in Miquelon in the early spring of 1970 and its identity confirmed by Leon Gaspard.

*GLOSSY IBIS (*Plegadis falcinellus*). — A single bird was recorded from June 29 to July 9, 1969 on a bog in the southwest of Grand Barachois, Miquelon. It was seen during this period by eight different people who were fully satisfied with their identification. This species occurs occasionally in Newfoundland (Tuck, 1968) and a single bird was present at St. John's about the same time as the Miquelon observation.

*WHISTLING SWAN (*Olor columbianus*). — An adult was shot by Eugene Perrot in Miquelon on October 23, 1966, and is now in the Musée. No specimen or positive sight record exists for Newfoundland.

*WHITE-FRONTED GOOSE (*Anser albifrons*). — MJB examined an adult bird shot in Miquelon in early November, 1961. It occurs rarely in Newfoundland where specimens indicate that the Greenland subspecies, *flavirostris,* is most likely to occur (Tuck, 1968).

*MALLARD (*Anas platyrhynchos*). — A male shot in St. Pierre in February, 1968, was mounted by Mr. Pierre Lapaix. According to residents of Miquelon, Mallards occur occasionally in the fall and winter with Black Ducks (*Anas rubripes*).

BLACK DUCK (*Anas rubripes*). — Cameron (1967) states that this species occurs only in small numbers. Actually it is the most popular game bird in the archipelago. It is especially common, during migration, on all the larger islands, and particularly in Grand Barachois. It also overwinters in fair numbers. On February 9, 1970 MJB recorded 250 birds south of Miquelon.

PINTAIL (*Anas acuta*). — Apart from the two observations recorded by Cameron (1967) MJB has four additional sight records during April and July and one winter record (February 23, 1964). It may possibly breed as it does (rarely) in Newfoundland since MJB observed a pair (male and female) in Miquelon on June 30, 1965.

BLUE-WINGED TEAL (*Anas discors*). — Cameron (1967) records two females on November 12, 1963 in Langlade. An adult male banded in Michigan on September 13, 1935 was shot in St. Pierre in August, 1943; and an immature male banded in New York on August 29, 1963 was shot in St. Pierre on August 26, 1964. This species is now breeding in Newfoundland and has been increasing its range during the past few years. Three were shot in Miquelon on August 30, 1971 and we saw one in association with Green-winged Teal (*Anas carolinensis*) at Langlade on August 18, 1971.

*AMERICAN WIDGEON (*Mareca americana*). — The head of an immature male shot on December 3, 1967, was preserved. This species was first recorded in Newfoundland in 1966 but has occurred every fall since. All are immature birds.

*EUROPEAN WIDGEON (*Mareca penelope*). — An immature banded in Iceland on June 28, 1947 was shot in St. Pierre on October 4 of the same year. At least five have been shot in Newfoundland, two of which had also been banded in Iceland. It seems likely that all the European Widgeon occurring in this region originate in Iceland.

WOOD DUCK (*Aix sponsa*). — Two males were shot in St. Pierre in October, 1959. Seven were shot from a flock on October 31, 1963 one of which, an immature, had been banded in New York on August 15, 1963. An adult male was shot November 17, 1965 and presented to the Musée. MJB observed a pair closely near St. Pierre on April 26, 1967. A male was shot (and mounted) in Miquelon in March, 1968 and in April of the same year another pair was observed by MJB. It occurs regularly but uncommonly in Newfoundland and has bred at least once.

*RING-NECKED DUCK (*Aythya collaris*). — An adult male was shot in Miquelon on April 23, 1965. On May 12, 1966 another male was shot in the same area. An adult male banded in South Carolina on February 17, 1965 was shot in Miquelon on April 19, 1965. According to hunters and MJB's observations, Ring-necked Ducks occur in small numbers associated with Greater Scaup on Mirande Lake and surrounding ponds in late winter and early spring. There are no breeding records for St. Pierre or Miquelon. It was first recorded in Newfoundland in 1948 (Tuck, 1949) where it is now one of the most common breeding ducks.

GREATER SCAUP (*Aythya marila*). — This species is found in winter and early spring in groups of 5 to 25, especially on Mirande Lake in Miquelon. A young male banded at Seneca Lake, N.Y. on March 23, 1965 was shot in St. Pierre on December 18, 1965. The Greater Scaup breeds locally in Newfoundland.

*BUFFLEHEAD (*Bucephala albeola*). — A single record: a male was shot by a hunter on December 3, 1967, central Miquelon. It had been in association with Common Goldeneyes (*Bucephala clangula*) and its identity was confirmed by MJB.

*HARLEQUIN DUCK (*Histrionicus histrionicus*). — Uncommon but well enough known by local hunters to be known vernacularly as "cane de roche" or rock-duck. They are usually in small flocks of 10-20 birds. A male collected off Miquelon on December 3, 1967 is now in the Musée.

*SURF SCOTER (*Melanitta perspicillata*). — Apparently very rare. MJB has but a single record of an adult male in Miquelon in December, 1969.

*RUDDY DUCK (*Oxyura jamaicensis*). — A female shot by Roger Dodeman in a pond west of St. Pierre on September 20, 1960 was examined and identified by MJB. There are several records for Newfoundland.

*HOODED MERGANSER (*Lophodytes cucullatus*). — MJB examined a female shot in Miquelon on April 8, 1965. It had been in company with a male. On January 6, 1970 an adult male was shot in Miquelon and on October 11, 1971 two females were shot in St. Pierre. The Musée also has an undated specimen collected on Isle aux Marins.

*COMMON MERGANSER (*Mergus merganser*). — This species is known by hunters but the only record we have is a male shot by a hunter on March 15, 1968 at Grand Barachois, Miquelon. It was identified by MJB.

*MARSH HAWK (*Circus cyaneus*). — Probably rare. MJB observed a single immature near Grand Barachois on September 10, 1969 and we saw another single immature on Langlade on September 18, 1971.

*SPARROW HAWK (*Falco sparverius*). — Regular observations, usually of single birds from September 28, 1965, to April 14, 1969. Four were recorded on September 18, 1971, three at St. Pierre and one on Langlade. There are no summer records. This species is fairly common in Newfoundland in summer and occasionally overwinters.

*RUFFED GROUSE (*Bonasa umbellus*). — This species was introduced to Langlade in September, 1965 with stock (14 birds) from Nova Scotia. At least 10 birds were seen in the same general area in September, 1969, some of which were young of the year.

*RING-NECKED PHEASANT (*Phasianus colchicus*). — Introductions were made around 1930 and again in September, 1964. In the latter, 100 birds were released on Langlade and Miquelon. Neither was successful as the birds did not survive the winter.

*CHUKAR (*Alectoris graeca*). — An introduction (100 Canadian birds) was made on Langlade and Miquelon in 1954. At least two birds survived until December, 1960 but none has been observed since.

*VIRGINIA RAIL (*Rallus limicola*). — An adult, shot in October, 1965, was donated to the Musée. One was obtained by MJB in Grand Barachois on October 14, 1971 and two in Langlade on October 16, 1971. It breeds rarely in Newfoundland.

*YELLOW RAIL (*Coturnicops noveboracensis*). — An adult, found long dead on October 23, 1965, was brought to MJB for identification. It was in too poor condition to preserve. There is no record for this species in Newfoundland.

*COMMON GALLINULE (*Gallinula chloropus*). — An immature, shot at St. Pierre on October 4, 1967 is in the Musée. This species occurs in Newfoundland rather regularly in October and November.

*KILLDEER (*Charadrius vociferus*). — A specimen collected in St. Pierre on May 2, 1968 is in the Musée. MJB has six observations of single birds in the fall and winter of 1968-69, and three birds on September 10, 1970. It has bred at least once in Newfoundland (Strauch, 1971) but occurs quite frequently in the fall and winter.

*GOLDEN PLOVER (*Pluvialis dominica*). — According to hunters this species occurs regularly in the fall when it associated with the more abundant Black-bellied Plovers (*Squatarola squatarola*). MJB's earliest observation is of a single bird on August 27, 1967 and his largest, a flock of 60-65 birds in Miquelon on September 10, 1968.

AMERICAN WOODCOCK (*Philohela minor*). — Cameron (1967) recorded a bird found alive in St. Pierre on March 31, 1964. MJB has three additional records: one shot on April 27, 1967, and single observations of birds on May 27, 1968, and December 17, 1965. It is rare in Newfoundland but may possibly breed.

*LESSER YELLOWLEGS (*Totanus flavipes*). — We observed a single bird in Langlade, possibly the same individual on September 18 and 19, 1971. It occurs regularly but uncommonly in the fall in Newfoundland.

*PECTORAL SANDPIPER (*Erolia melanotos*). — We flushed several birds from a grassy meadow on the Dunes in Langlade on September 18, 1971. It occurs regularly in Newfoundland in the fall.

*MARBLED GODWIT (*Limosa fedoa*). — The head of a single bird, shot in Miquelon on October 2, 1967 by Mr. A. L. Detcheverry, was preserved. There is but a single sight record for Newfoundland.

*PARASITIC JAEGAR (*Stercorarius parasiticus*). — Only three records, two shot on the same day, an adult and an immature in St. Pierre harbour on August 30, 1970, and an adult observed in Langlade on June 19, 1971.

*BLACK-HEADED GULL (*Larus ridibundus*). — This European species, which has occurred in Newfoundland every month of the year but most commonly in the winter, has been definitely recorded only twice in our area. An adult, shot at St. Pierre from a flock of 14 on April 17, 1967 was donated to the Musée. Another, in first winter plumage, was collected at Miquelon on December 8, 1968.

*CASPIAN TERN (*Hydroprogne caspia*). — An adult, collected at St. Pierre, is mounted in the Musée but the precise date of occurrence is not recorded. It breeds rarely in Newfoundland.

*BLACK TERN (*Chlidonias niger*). — An immature was shot at St. Pirere on September 14, 1968. It occurs occasionally in Newfoundland.

*THICK-BILLED MURRE (*Uria lomvia*). — Not recorded by Peters and Burleigh (1951) or Cameron (1967), this species is regularly shot by hunters in

the winter. Banded birds from the Canadian Arctic and West Greenland have been recovered off St. Pierre and Miquelon.

*BLACK-BILLED CUCKOO (*Coccyzus erythropthalmus*). — An adult with broken wing was captured at Ross's Cove, Langlade on June 6, 1965. It occurs in Newfoundland most frequently in the spring and early summer.

*YELLOW-BILLED CUCKOO (*Coccyzus americanus*). — MJB observed a single bird at St. Pierre on September 30, 1966 and another in the same locality on September 1, 1970. This species occurs as a drift-migrant in Newfoundland in the fall, occasionally in rather large numbers.

*LONG-EARED OWL (*Asio otus*). — An adult collected at St. Pierre in the spring of 1969 is now in the Musée. It has not been recorded for Newfoundland.

*BOREAL OWL (*Aegolius funereus*). — An adult male was found dead in Miquelon on November 7, 1965. In some years it occurs in large numbers in Newfoundland, always in the fall and winter.

RUBY-THROATED HUMMINGBIRD (*Archilochus colubris*). — MJB observed a female for more than 20 minutes at Soldiers Cove, Langlade on June 6, 1970. Another at St. Pierre on September 20, 1964 was recorded by Cameron (1967). It is rare but has bred in Newfoundland.

*YELLOW-BELLIED SAPSUCKER (*Sphyrapicus varius*). — Apparently only occurs in the archipelago during fall migration. MJB observed an immature at St. Pierre on October 3, 1966 and another immature was captured and later released in the same locality on October 4, 1967. We saw fresh Sapsucker borings at Langlade on September 19, 1971.

*DOWNY WOODPECKER (*Dendrocopos pubescens*). — No breeding records but MJB received an adult from Miquelon on November 20, 1963, and saw two on December 20, 1965, at Miquelon; another at St. Pierre on May 7, 1967; and two at Miquelon, October 15, 1971.

*WESTERN KINGBIRD (*Tyrannus verticalis*). — MJB observed an adult near St. Pierre on October 8, 11, and 30, 1965 and another in the same locality from November 30-December 1, 1970. It has occurred infrequently in Newfoundland in the fall months only.

*RED-BREASTED NUTHATCH (*Sitta canadensis*). — Peters and Burleigh (1951) recorded a single bird of this species. However, MJB has found it to be fairly common from May to October, especially west of St. Pierre and in sheltered valleys of Langlade and Miquelon. We found it extremely abundant, probably in hundreds, in the sheltered valleys of Langlade on September 19, 1971.

MOCKINGBIRD (*Mimus polyglottos*). — Cameron (1967) recorded several for October and November, 1965. Since then, MJB has recorded single individuals at St. Pierre on September 28, 1966; October 16, 1967; November 1, 1968; and daily from November 14, 1968 to February 15, 1969. He found one dead at St. Pierre on December 15, 1967. This species has bred locally in Newfoundland in recent years where it seems to be resident but occasional individuals in the spring and fall at Ramea, off the southwest coast, indicate some migration.

CATBIRD (*Dumetella carolinensis*). — Cameron (1967) recorded a single bird at St. Pierre on June 23, 1964. MJB recorded a single bird at St. Pierre on June 5, 1965, and another at Langlade on May 30, 1971. It is rare also in Newfoundland.

*VEERY (*Hylocichla fuscescens*). — Two observations, both in spring. MJB recorded a single bird at Langlade on May 30, 1965, and another in St. Pierre on May 8, 1966.

*GOLDEN-CROWNED KINGLET (*Regulus satrapa*). — Cameron (1967) recorded this species absent from the archipelago. However, since 1965, MJB has recorded it regularly all throughout the year, although it appears to be more abundant in the winter (October to March).

*BOHEMIAN WAXWING (*Bombycilla garrulus*). — A male and a female shot in Miquelon on February 9, 1969, were donated to the Musée. Bohemian Waxwings were also present at several localities in Newfoundland at the same time.

*BLUE-WINGED WARBLER (*Vermivora pinus*). — MJB had four of those birds under observation for some time at Miquelon on September 27, 1968. It has occurred also in Newfoundland on at least three occasions.

*MYRTLE WARRLER (*Dendroica coronata*). — Possibly breeds. It has been recorded in Langlade and St. Pierre regularly in the spring and fall and occasionally in the summer. Extreme dates are May 9, 1968, and October 30, 1965.

*CHESTNUT-SIDED WARBLER (*Dendroica pensylvanica*). — MJB observed a male in St. Pierre on May 26, 1965. It has occurred (also only males) in Newfoundland on at least three occasions (Tuck, 1967).

*BAY-BREASTED WARBLER (*Dendroica castanea*). — MJB observed a male in Langlade on June 20, 1967, and two others in the same locality on July 13, 1967. It is uncommon in Newfoundland.

*OVENBIRD (*Seiurus aurocapillus*). — This warbler is quite common in Newfoundland but has been recorded in the archipelago on only two occasions. An adult was collected on Langlade on September 14, 1965 and another seen in St. Pierre on May 26, 1966.

*YELLOW-BREASTED CHAT (*Icteria virens*). — This species occurred at least three times in the archipelago:

on October 30, 1965; October 3, 1968 (one found dead); and October 14, 1968, all at St. Pierre. It is possibly a drift-migrant in our region, since the majority of records from Newfoundland are also in the fall or early winter (Tuck, 1952; 1967).

*BOBOLINK (*Dolichonyx oryzivorus*). — An adult was captured and photographed at St. Pierre by MJB on May 26, 1966. A male was observed on May 13, 1968, and for the following four days; a pair on June 11-14, 1968; a single male on June 20, 1968; and a male on June 5, 1969, all at St. Pierre. This species breeds but is rather rare in Newfoundland.

*EASTERN MEADOWLARK (*Sturnella magna*). — An adult collected in October, 1964, was presented to the Musée. MJB has records of an immature shot in St. Pierre on November 2, 1966, and another immature shot in Miquelon on November 5, 1967. It occurs in Newfoundland occasionally.

*BALTIMORE ORIOLE (*Icterus galbula*). — An immature banded in Rhode Island on October 3, 1963 was found dead in St. Pierre on November 11, 1963 — an interesting example of drift-migration. A flight of this species reached the archipelago in early spring 1967. Between April 23 and May 23, 1967, MJB frequently saw Baltimore Orioles in St. Pierre as many as five males on one occasion. He saw a female or immature at St. Pierre on October 13, 1967. This species occurs regularly spring and fall, and occasionally overwinters, in Newfoundland.

*RED-WINGED BLACKBIRD (*Agelaius phoeniceus*). — Observed regularly since 1965, usually in the winter (November and January) and always single birds. However, one was observed on June 20, 1968, and two separate birds on June 14, 1969. An adult male first seen on November 3, 1965 was collected on November 20. On September 20, 1968, one arrived at Miquelon with a cargo of sheep from Sydney, Nova Scotia. This species breeds and is recently extending its range in Newfoundland.

*SCARLET TANAGER (*Piranga olivacea*). — Observations of single males in St. Pierre on June 12, 1967; May 25, 1968; April 24, 1969; and May 16, 1970. A female or immature was recorded on October 13, 1967. It is a rather frequent drift-migrant to Newfoundland, particularly in the early spring.

*SUMMER TANAGER (*Piranga rubra*). — MJB took movies of a female at St. Pierre on October 16 and 18, 1966. It has not been recorded in Newfoundland.

ROSE-BREASTED GROSBEAK (*Pheucticus ludovicianus*). — On May 26, 1964 an adult male was captured, photographed, and released in Miquelon by Leon Gaspard. An immature was observed in St. Pierre on September 27, 1967; and an adult in company with an immature (or female) in St. Pierre on October 13, 1967. It has occurred from May to October in Newfoundland where it possibly breeds rarely.

*EVENING GROSBEAK (*Hesperiphona vespertina*). — It has occurred in small numbers during the winters since 1961, at St. Pierre and Langlade. The earliest record is September 14, 1965 and the latest May 17, 1969. It occurs regularly in Newfoundland in the winter and possibly breeds rarely.

*RED CROSSBILL (*Loxia curvirostra*). — The only records are a flock of 12 on July 28, 1965, and three on September 19, 1971 at Langlade.

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Notes

The Short-tailed Albatross Recorded at Ocean Station Papa, North Pacific Ocean, with Notes on other Birds

Abstract. A juvenile Short-tailed Albatross (*Diomedea albatrus*) was observed and photographed at Ocean Station Papa (OSP), 50°N, 145°W, North Pacific Ocean in June, 1971. The presence of numerous pelagic birds, including the New Zealand Shearwater (*Puffinus bulleri*), at OSP is recorded. The occurrence of land birds (Ruddy Turnstone, Savannah Sparrow, Northern Phalarope, Mallard, Shoveller, Western Sandpiper, Lapland Longspur) at OSP during August-September 1969 is believed to be related to fall migration.

Introduction

In general terms, the pelagic bird fauna of the North Pacific Ocean is well known, but few people have the good fortune to observe pelagic birds over extended periods of time. However, for personnel on board the Canadian Coast Guard vessels which man Ocean Station Papa (OSP), such an opportunity is available, and the ships' officers routinely make observations on the numbers and species of birds seen. Occasionally scientists working aboard the ships supplement these observations.

In the present paper, we list and comment upon the bird species seen during two tours of duty of C.C.G.S. "Quadra" at OSP, one during August-September 1969, the other during May-June 1971. OSP is situated at 50°N, 145°W, about 1000 miles west of Vancouver Island.

Pelagic Birds

The most unusual bird which we observed during May-June 1971 was a juvenile Short-tailed Albatross (*Diomedea albatrus*). This species was, at one time, a common bird in the North Pacific (Palmer, 1962), but because of wholesale slaughter for the feather trade earlier in this century there were only 23 adult birds in 1953 (Red Data Book, 1966). Since that time the population has increased so that in 1958-59, 18 chicks were hatched (Fauna Preservation Soc., 1966, total population given as "more than fifty birds") and in 1962 the population was recorded as 47 birds (Red Data Book, 1966). Since 1954, this species has been recorded in the eastern latitudes of the North Pacific Ocean only six times (Sanger, 1964; Poole, 1966; Tramontano, 1970), and it is noteworthy that four of these observations were made within 300 miles of Torishima Island (Tramontano, 1970), the only island on which this species is now known to nest (Rice and Kenyon, 1962). In the western latitudes of the North Pacific, the Short-tailed Albatross has, since 1954, also been reported only six times (Lane, 1962; Wyatt, 1963; Boggs and Boggs, 1964; Bourne, 1967; Wahl, 1970). We feel it is especially worthwhile, therefore, to document the occurrence of this species away from the nesting island. We observed the Short-tailed Albatross on 24, 25, and 26 June 1971 and fortunately the sea was calm enough to permit us to photograh the bird (Fig. 1). Dr. W. E. Godfrey, Curator of Ornithology, National Museum of Natural Sciences, Ottawa, has confirmed our identification from the photographs shown as well as from colour slides. The plumage was uniformly very dark brown, and the legs and feet were pinkish-white. The bill, except for a dusky tip, was also pinkish-white. These characteristics readily serve to distinguish the juveniles of this species from the Black-footed Albatross (*Diomedea nigripes*), which has a white face, white rump patch, and dark bill, legs, and feet. The plumage of the Black-footed Albatross is conspicuously lighter than that of the Short-tailed Albatross (Figure 1).

The Short-tailed Albatross is reputed to be a relatively shy bird (Palmer, 1962) and our observations confirm this. It preferred to remain some distance from the ship (up to several hundred yards), flying or swimming near the stern on only a few occasions. By contrast, Laysan (*Diomedea immutabilis*) and Black-footed albatrosses were frequently observed only several yards from the ship. Tramontano (1970) reports that the Short-tailed Albatross does not mingle with either the Laysan or Black-footed Albatross. We observed that at times (e.g. Fig. 1) the Short-tailed was in close company with the Black-footeds, but that at other times it remained apart from them and would swim away from approaching Black-footeds.

Several species of birds are quite common at OSP, sometimes in flocks of more than 25 individuals, although the numbers vary both with season and weather. These include the Black-footed Albatross, Fork-tailed Petrel (*Oceanodroma furcata*) and Fulmar (*Fulmarus glacialis*), this latter species appearing in light, dark, and a

Figure 1. Above: The Short-tailed Albatross (foreground) and a Black-footed Albatross: note the darker plumage of the Short-tailed Albatross. Below: The Short-tailed Albatross: note the light-coloured bill and legs.

variety of intermediate colour phases. Leach's Petrel (*Oceanodroma leucorhoa*) is infrequently seen during the day, but is often found on the deck of the ship at night, and it is undoubtedly this species which can be seen flying around the ship after dark. Laysan Albatrosses are frequently seen, especially during the later summer months. During the May - June 1971 trip there were seldom more than two specimens in sight at any one time. One of us (A.A.R.D.) feels that there has been a slow but steady decline in the number of Laysan Albatrosses at OSP over the past several years.

Certain pelagic species are seen only occasionally. On 27 August 1969, we noticed a flock of 200-300 unusual shearwaters which we finally identified as New Zealand Shearwaters (*Puffinus bulleri*). The striking inverted "W" which can be seen on the back and wings of flying birds is unmistakable once recognized. Other noticeable features of this species are the black "cap" with a "sideboard" effect on the neck, a pointed tail, and milky white underparts. This species has only recently been recorded, with a specimen, in Canada (Campbell, 1970). We saw a flock of about 50 Black-legged Kittiwakes (*Rissa tridactyla*), including both mature and juvenile birds, on 26 May 1971, and one or a few individuals on eight subsequent occasions. On 20 June 1971 we identi-

fied a Common Murre (*Uria aalge*) and unidentified murres (either Common or Thick-billed (*U. lomvia*) were seen at other times. Between 13 and 18 June 1971, Tufted Puffins (*Lunda cirrhata*) were seen four times, either as single birds or as pairs. Godfrey (1966) has mentioned that this species winters at sea, and the records of one of us (A.A.R.D.) confirm that more are seen at OSP in the winter than during the summer months. Infrequently, predatory pelagic birds such as the Skua (*Catharacta skua*), Pomarine Jaeger (*Stercorarius pomarinus*), and Long-tailed Jaeger (*S. longicaudis*) or Parasitic Jaeger (*S. parasiticus*) are seen, but these remain near the ship for only brief periods. Sooty Shearwaters (*Puffinus griseus*) which we saw in large numbers near the coast, were seen on only three occasions in May-June 1971 after the ship had reached OSP. Terns, which we tentatively identified as Arctic Terns (*Sterna paradisea*) were seen three times during May-June 1971.

Continental Birds

During the August-September, 1969 trip, a number of birds not usually seen at sea were observed at OSP. On 14 August a Ruddy Turnstone (*Arenaria interpres*) landed on the ship and remained on board for several days. The turnstone was observed to swim alongside the ship on several occasions. A pair of Savannah Sparrows (*Passerculus sandwichensis*) remained on the ship for several hours on 25 August. On 31 August a Northern Phalarope (*Lobipes lobatus*) was seen and on 4 September a female Mallard (*Anas platyrhynchos*) was observed swimming around the ship. The head of a female Shoveller (*Spatula clypeata*) was found on the deck on the morning of 8 September. Presumably the bird was flying low at night, was decapitated by a guy wire or antenna and its body fell into the ocean. Late in the afternoon of 11 September two Western Sandpipers (*Ereunetes mauri*) landed on the ship; one of these was stunned when it flew into a bulkhead. After we examined the specimen, we released it whereupon it flew off the ship, landed in the water and was promptly attacked and eaten by three Black-footed Albatrosses. Two Lapland Longspurs (*Calcarius lapponicus*) landed on the ship on the evening of 16 September. One of these was captured, positively identified and subsequently released.

Although land birds observed some distance at sea are often thought to have been blown there by storms, this does not appear to have been the case with the species mentioned above. The sightings of land birds occurred over more than a one month period during which there were few strong easterly winds which could have blown the birds out from land. Furthermore, no land birds were observed during the May-June 1971 trip. However, one explanation which takes these facts into account springs to mind. All of the land birds observed at OSP during August-September 1969 occur in Alaska, and as it was late in the season they may have been migrating southward.

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C. G. GRUCHY[1], A. A. R. DYKES[2], R. H. BOWEN[1,3]

[1]Ichthyology Unit, National Museum of Natural Sciences, National Museums of Canada, Ottawa, K1A 0M8, Ontario

[2]Master, CCGS *Quadra,* 211 Harbour Road, Victoria, B.C.

[3]Summer student under the "Career Introduction Program".

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Fannin's Color Variation of the Dall Sheep, *Ovis Dalli,* in the Mentasta Mountains of Eastern Alaska

Within the American snow sheep species *(Ovis dalli)* there are two major color variations — the pure white Dall sheep found throughout much of Alaska and a considerable portion of the Yukon Territory, Canada, and the charcoal-gray Stone sheep found in northern British Columbia. However, in the central and southern parts of the Yukon Territory the demarcation between these color patterns is unclear and many populations share both color variants along with many intermediate gradations of the gray-white pattern. These mixed light gray sheep were originally referred to as a separate species — Fannin sheep *(Ovis fannini)* — but it has long since been recognized that these are representatives of a species cline. For references sake their color pattern is still given the name Fannin pattern, or sometimes "saddle-back" sheep, as the gray coloring in its weakest expression is confined to the dorsal shoulder and saddle areas. See Sheldon (1925) for an early discussion of these variants.

With the exception of a few black tail specimens of Dall sheep which occur in the Yukon Tanana upland, Alaskan sheep are considered to be pure white. I have confirmed Sheldon's observations that the sheep from the Yukon-Tanana upland do indeed have a high frequency of black tails (this is the standard tail pattern within the Stone sheep variant). I have photographs of a ewe, a yearling which seemed to be attached to her (possibly her lamb from the previous summer) and a new lamb. All three individuals have black tails. Other sheep in the White Mountains (a suite of hills within the Yukon-Tanana uplands) were also seen to have black tails or black hairs in the tail. However, there was no indication of any Fannin patterns of gray hairs on the dorsal part of the body.

Many Alaskan sheep are stained a dusky sand color from the rocks and soil and perhaps some from vegetation. This appears on close inspection as "singeing," as it is only the distal portion of the hair which is discolored and is not easily mistaken for the gray Fannin color variations.

During August of 1971 I was in the Mentasta Mountains (see map in Fig. 1 for location) which is technically an extension of the Alaska Range eastward toward Canada and was able to observe three sheep which were of the Fannin pattern. Many sheep were badly stained to a sand color but these three individuals stood out as quite distinctly different. Their backs and flanks were quite gray.

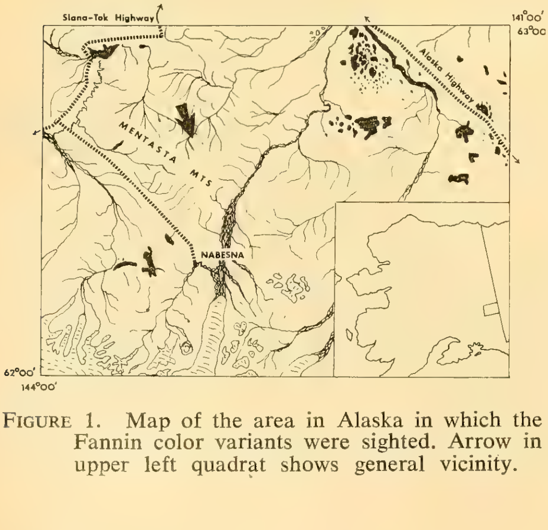

FIGURE 1. Map of the area in Alaska in which the Fannin color variants were sighted. Arrow in upper left quadrat shows general vicinity.

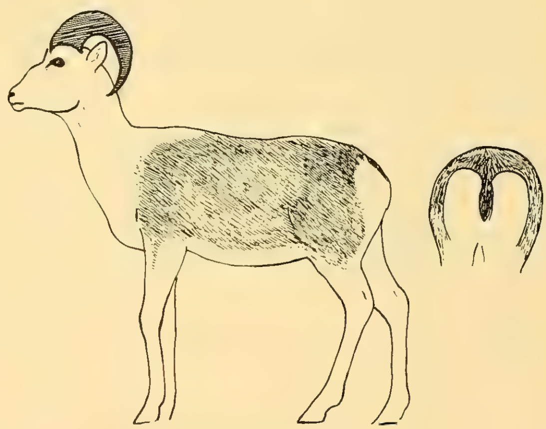

FIGURE 2. An illustration of the distribution of gray hairs over the body of the young ram.

One of these was a young ram. The other two were ewes. I was able to observe the ram at relatively close range with a spotting scope and record the exact distribution of the gray pattern on the body (Fig. 2). The gray extended down well onto his sides, back, and rump. In the rump area a white rump patch was clearly outlined and the tail was dark, but not as black as the Stone sheep's but still darker than the rest of the body. Judging from his horns, this ram was between 3-4 years old. Another ram, an older member of

the same ram band, was shot and found to have numerous black hairs on the tail.

I observed somewhere over one hundred sheep in total, which means that the occurrence of the Fannin variations was at a relatively low percentage. However, a number of these sheep were seen at a long distance before the gray-back sheep were seen and it is possible that some of these would have proved to be Fannin color variants had I examined them more closely and from a shorter range.

It is part of the folklore of the Alaskan hunters and trappers that small isolated bands of Fannin variants exist in the Yukon-Tanana upland and/or in the Alaska Range. Since these had never been observed by Fish and Game Department sheep surveys or reputable guides, it has been assumed that these variants probably do not exist. The occurrence of a few individuals in at least one area, which I have described, may explain how hunters actually seeing or shooting isolated Fannin color variants may have led to the rumors of whole Fannin populations.

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R. D. GUTHRIE

College of Biological Sciences
and Renewable Resources,
University of Alaska,
College, Alaska 99701 U.S.A.

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New Records of Freshwater Fishes from the Northwestern Coast of Insular Newfoundland

Abstract. *Salmo salar, Salvelinus fontinalis, Salvelinus alpinus, Osmerus mordax, Anguilla rostrata, Gasterosteus aculeatus, Apeltes quadracus* and *Pungitius pungitius* were collected from fresh waters of the Bonne Bay region, northwestern insular Newfoundland. These records include the first collection of *Apeltes quadracus*, the fourspine stickleback, from completely fresh, standing water in Newfoundland. Peripheral division freshwater fishes remain the only reported species from insular Newfoundland.

The study of the freshwater fishes of insular Newfoundland has been hampered in the past by the inaccessibility of large areas of the island. Scott

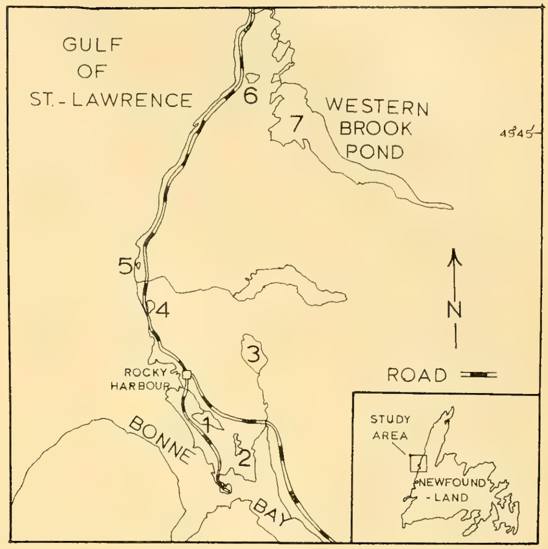

FIGURE 1. Map of the Bonne Bay area, western insular Newfoundland showing the localities where the fishes were collected. Numbers by the lakes indicate the stations as listed in Table 1.

and Crossman (1964), surveyed 50 localities on the island but made no collections from the Great Northern Peninsula; nor did Garside (1970) in his work on some of the newly accessible areas of central Newfoundland. Van Vliet (1970) surveyed four freshwater localities in the Great Northern Peninsula but all were streams close to or under the influence of estuarine conditions. As mentioned by Garside (1970), the Great Northern Peninsula is important in the distribution and zoogeography of the freshwater fishes of insular Newfoundland because it approaches closest to the source area of the mainland. If obligate freshwater fishes have reached insular Newfoundland this would have been one of the most likely dispersal routes.

The present survey was conducted by the author during a survey of the fresh waters of the proposed Gros Morne National Park from July 1 to July 29, 1969. It extends the sampling of the freshwater fish fauna of the island part way up the Great Northern Peninsula.

The lakes and ponds sampled are shown in Figure 1. The sites were selected more on a basis of their different limnological characters than for any other reason. Sampling was carried out using seines, gill nets, scoop nets, an otter trawl and angling gear. Fishes captured are listed in Table 1.

TABLE 1. — Freshwater fishes captured in the Bonne Bay region, western Newfoundland. Station number locates geographical position of localities in Fig. 1. Plus sign (+) indicates presence of species. Total hardness data are from Dadswell (1970).

Station	1	2	3	4	5	6	7
	Rocky Harbour Pond	Neddy Harbour Pond	Lower Deer Pond	Berry Head Pond	"unnamed" Pond	Gull Pond	Western Brook Pond
Total Hardness (ppm)	71	136	8	13	12	14	9
Salmo salar	–	–	+	–	–	–	+
Salvelinus fontinalis	+	+	+	+	–	–	+
Salvelinus alpinus	–	–	–	–	–	–	+
Osmerus mordax	+	–	–	–	–	–	–
Anguilla rostrata	+	–	+	+	–	–	–
Pungitius pungitius	–	–	–	+	+	–	–
Gasterosteus aculeatus	+	+	+	+	+	+	+
Apeltes quadracus	–	–	–	–	+	–	–

These collections are now stored at the Royal Ontario Museum (Acc. No. 1642) except for the Arctic char which was sent to Mr. Lloyd Saunders of the University of New Brunswick for use in electrophoresis studies of Arctic char taxonomy.

To the author's knowledge, this survey is the first to record *Apeltes quadracus,* the fourspine stickleback from standing freshwaters in Newfoundland station 5 (Total hardness 12 ppm.). Scott and Crossman (1964) found this fish only in brackish environments. Van Vliet (1970) captured *A. quadracus* in the fresh water portion of a brook just as it entered the sea (NMC66-170).

The other fishes found in the survey are common to fresh water throughout insular Newfoundland. The occurrence of Arctic char in Western Brook Pond is interesting. It is not known whether this population is landlocked or anadromous, but only a few miles to the north, at Parsons Pond, there is a small anadromous population of char (Scott and Crossman, 1964). As usual *Salvelinus fontinalis* and *Gasterosteus aculeatus* are the most common fish, occurring in 5 of 7 and 7 out of 7 localities respectively.

Obligate freshwater fish were not found. Only the northern part of the Great Northern Peninsula remains to be investigated to discover whether the dispersal of obligate freshwater fish from the mainland to this part of insular Newfoundland has occurred.

Acknowledgements

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MICHAEL J. DADSWELL

Department of Biology,
Carleton University,
Ottawa, Ontario

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A Nova Scotian Kittiwake Colony

On June 7, 1971, while engaged upon a census of seabirds breeding in Nova Scotia, I visited Green Island off Port Gabarus, Cape Breton Island. On the cliffs on the northeastern side of the island an estimated 90 pairs of Black-legged Kittiwakes (*Rissa tridactyla*) were nesting. This is the first recent record of this species breeding in Nova Scotia. Twenty-seven pairs of Great Cormorants (*phalacrocorax carbo*) occupied one end of the island and an estimated 130 pairs of Great Black-backed Gulls (*Larus marinus*) nested on the remainder of the top of the island. Fourteen Black Guillemots (*Cepphus grylle*) were counted around the island and were observed entering and leaving clefts in the rocks.

As the sea was rough I was only able to land briefly and I was not able to inspect all of the Kittiwake colony. Seventy-seven nests were counted and the cliff-faces which were not visible from the water were estimated to have a further dozen or more nests. The nests were of fine grasses and sea weed set on narrow ledges more than 2m above the supralittoral fringe. In the nests I inspected there were six clutches of three eggs, seven of two eggs, and two of one egg.

In Europe the Kittiwake has been increasing its breeding range and numbers for the last half century. Fisher and Lockley (1954) report that it began to breed in Brittany around 1941 and on one of the Channel Islands in 1938. More recently, Coulson and MacDonald (1962) describe an increase in numbers of Kittiwakes in part of Britain, and Mathiasson (1968) and Ergvik (1966) report new and enlarging colonies in Scandinavia.

Audubon (1840) said that this species bred on Grand Manan Island, though Palmer (1949) believes that this record is erroneous. This species, in Europe, breeds as far south as the 60° July isotherm which, in North America, falls around Cape Cod. If the breeding distribution of the Kittiwake is in any way related to water temperature it seems possible that it may previously have bred in Maine or New Brunswick. But in this century it has not been known to breed south of the Magdalen Islands or Cape St. Mary in Newfoundland. I was not able to determine whether this colony is of recent origin: the few fishermen I talked with were not aware of its existence.

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ANTHONY R. LOCK

Biology Department,
Dalhousie University,
Halifax, N.S.

Received January 18, 1972
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A New Distributional Record for the Gadwall

In North America, the Gadwall (*Anas strepera*) is described to be a resident species of temperate climates seldomly venturing northwards to the higher latitudes. Nevertheless, in Alaska, it has been reported to exhibit scattered and infrequent residency north of the Alaska Range (Kessel and Springer, 1966). Also, Dixon (1938) reported the species to be one of the rarer species of waterfowl to breed in Mt. McKinley National Park. Occasionally sightings have been reported for the interior of the State especially in the vicinity of Fairbanks and further east at Tetlin and Merganser Lakes (Kessel and Springer, op. cit.). Occurrence above the Arctic Circle has been suggested but the field reports lack positive identification.

On June 8, 1971, I collected the carcass of a male Gadwall approximately one mile inland from the Arctic coast and southeast of Prudhoe Bay, Alaska (70°18′30″N, 148°16′W). The carcass, other than for an air-dried appearance and texture, showed no signs of decay or water-rot. Both wings were intact and all primaries present to permit positive field identification. The condition of the carcass suggests this drake fell victim to the

attack of an Arctic fox (*Alopex lagopus*) during spring break-up. Predation on waterfowl and shorebirds and their nest sites by foxes was unusually high for the Prudhoe Bay area in 1971 since microtine populations were low in density (Child, 1971, pers. observ.).

This find represents the northernmost occurrence of the Gadwall reported to date in continental North America (Godfrey, 1966). Both wings have been preserved and are presently filed in the Biological Collections in the University of Alaska Museum (Voucher Specimen No. UA3239).

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KENNETH N. CHILD

Alaska Co-operative Wildlife Research Unit,
University of Alaska
Fairbanks, Alaska 99701

Received March 14, 1972
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Robin Attacks Garter Snake

On July 22, 1971, at Wells Gray Park, British Columbia, an American Robin (*Turdus migratorius*) was seen engaged in combat with a 9" Common Garter Snake (*Thamnopsis sirtalis*) at the edge of a cedar-hemlock forest. My attention was first attracted by the shrieking alarm calls of the bird. The robin picked up the snake, usually by the tail, quickly dropping it. The snake was alternately picked up and then pecked about the head region. Picking up and pecking continued for some eight minutes until the snake was almost dead. It is possible that a nest was located somewhere near by and defence of territory initiated the aggressive behavior.

Common garter snakes apparently are uncommon predators on nestling birds. Fitch (1941) gives the frequency of predation on nestling birds of *T. sirtalis* as nil. Campbell (1969) reports the species an adept climber going as high as eight feet above the ground to get at nestling crows. There is apparently a record of the snake feeding on nestling Yellow Warblers.

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AL GRASS

5666 Rumble Street,
Burnaby 1, B.C.

Received January 4, 1972
Accepted April 27, 1972

Weasel Harasses Rock Ptarmigan

Near Frobisher Bay, N.W.T., at approximately 13:30 on July 21, 1971, two other people and I noted a covey of one adult and three immature Rock Ptarmigan (*Lagopus mutus*). At the same time we noticed a small brown animal harassing them.

The adult female imitated the actions of a wounded bird in an attempt to lead the predator away. She was partially successful as the animal followed her. After pursuing the hen for about 20 yards, the predator appeared to lose interest in the quarry and ranged toward us. It approached to within 20 feet of us and was very curious, but not afraid. At this point we confirmed the mammal to be a weasel (*Mustela erminea*).

The weasel darted behind a rock and we heard one squeak. Subsequently the weasel reappeared with a small animal in its mouth, presumably a shrew. The weasel put the shrew on a rock and licked it about the head and neck. It then carried the prey over 100 yards out of our sight. At this point it was about 150 yards from the initial site of attack on the ptarmigan.

I went to view the ptarmigan closer and approached to within 10 to 12 feet of them. They were nervous but did not fly. Then, I noticed the weasel returning over the same general route that it had exited by. It returned to the remaining ptarmigan. I was only 15 feet away.

The weasel made repeated lunges at the birds, mostly from behind. Apparently it purposely stopped just short of actual contact. At one point it removed a couple of feathers from one bird, but at no time could the attack be termed fero-

cious. The ptarmigan made no attempt to fly even though they appeared capable of flight. They merely scuttled off when under direct attack. Neither ptarmigan nor weasel were visibly affected by my presence. These sorties continued for at least 10 minutes in my presence and then I left. The adult bird was not observed after her initial departure.

DANIEL F. MURPHY

Government of the Northwest Territories,
Game Management Service,
Pangnirtung, N.W.T.

Probable Sightings of Little Shearwaters, *Puffinus assimilis*, on the Southeastern Grand Banks

Recent reports (Post 1967; Dr. P. Germain, pers. comm.) have shown that the Manx Shearwater, *Puffinus puffinus,* of the eastern Atlantic is a scarce but regular visitor to the waters off Newfoundland and Nova Scotia. Two other, smaller, black-and-white shearwaters have also been recorded. Audubon's Shearwater, *P. l'herminieri,* breeding in the Caribbean, occurs fairly regularly in warm Gulf Stream waters between July and September, but apparently does not go farther north than about 41°N unless storm-driven (Post 1967). The Little Shearwater, *P. assimilis,* from the Azores and other subtropical Atlantic islands, is much rarer. This species is found in cooler waters than *l'herminieri* (Palmer 1962). The northern and western limits of its range at sea are obscure, but Post (1967) notes an August specimen from South Carolina and a September one from Sable Island, Nova Scotia; he also lists possible sightings off New York (January), at 49°53′N 38°43′W (August), at 48°34′N 33°38′W (August), 50°30′N 40°00′W (November) and 44°07′N 38°43′W.

I had several sightings of small black-and-white shearwaters at the southeast edge of the Grand Banks, while on cruise 183 of the Fisheries Research Board trawler "A. T. Cameron" in early 1971. (I saw none at the southwest edge, or over the plateau of the Bank.) The first was on February 28, at 42°56′N 50°47′W, when a shearwater joined the flocks of Kittiwakes *Rissa tridactyla* around the ship as we were hauling nets. This bird was conspicuously smaller than the Kittiwakes. Its upperparts were black, sharply demarcated from the white underparts; the white on the cheeks extended up to eye level, and behind the head it extended a little way onto the sides of the neck, giving the effect of a half collar. The flight was very characteristic — three or four very fast wingbeats, followed by a long glide; sometimes these rapid wingbeats were sustained for longer periods. The bird was feeding, either on offal or on small organisms washed out of the nets; it picked food off the surface while swimming and also dived — either while on the surface, or flying a yard or so above it. This shearwater stayed with the ship for about half an hour and I had several close views of it, in reasonable light.

I also saw single birds on March 1 at 43°05′N 50°47′W and 43°26′N 50°07′W, and pairs on March 5 at 43°17′N 51°28′W and 43°21′N 51°26′W (these last two sightings perhaps refer to the same birds). These seldom came as close as on February 28, but the black-and-white colouring, the small size, and the method of flight were always characteristic.

I am familiar with Manx Shearwaters. The size of the birds I saw, the very rapid wingbeats, and the extent of white on the cheeks would seem to rule out that species. To judge from museum specimens and published accounts (e.g. Alexander 1963, Palmer 1962, Watson 1966) the very dark upperparts of my birds seem closer to *assimilis* than to *l'herminieri,* and so does the extent of white on the cheeks. The sea surface temperatures where the birds were sighted were cool (ranging between −0.5°C and 3.6°C), and this too suggests *assimilis* rather than *l'herminieri.* In any case, Post's (1967) fig. 3 shows that neither species has previously been recorded from the Grand Banks.

Further details of these sightings have been deposited with the PIROP seabird reporting scheme (Dr. P. Germain, Université de Moncton).

I am grateful to Dr. P. Germain, Dr. E. L. Mills and Dr. C. E. Tull for their comments. I should like to thank the Director, Fisheries Research Board, St. John's, Newfoundland, for permission to work on the "Cameron", and A. J. Pinhorn, Capt. G. Walters and the ship's personnel for their help.

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R. G. B. BROWN

Canadian Wildlife Service,
Marine Ecology Laboratory,
Bedford Institute,
Dartmouth, N.S.

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Thayer's Gulls Wintering off Western Newfoundland

Thayer's Gull, *Larus thayeri,* is a close relative of the Herring Gull, *L. argentatus.* Godfrey (1967) notes that it breeds in the Canadian arctic islands and winters "on the Pacific Coast of North America from southern British Columbia south to California". I was therefore interested to see several of these birds in western Newfoundland, early in 1971.

My observations were made in the course of cruise 181 of the Fisheries Research Board trawler "A. T. Cameron", along the southern and western Newfoundland coasts. I found that the commonest *Larus* gulls on this cruise were Iceland Gulls, *L. glaucoides,* (mainly *L. g. kumlieni,* but with a few *L. g. glaucoides*), followed by Great Black-backed Gulls, *L. marinus;* Herring and Glaucous Gulls, *L. hyperboreus,* were scarce.

I am familiar with Thayer's Gull in the arctic, but did not think to look for it on this cruise until January 30, when the ship was moored at Woody Point harbour (49°30′N 57°55W′), Bonne Bay. There, I had close views of at least two Thayer's Gulls. These birds had the appearance of adult Herring Gulls, but with dark brown, not black wing-tips; the brown area was about as large as the black area in the Herring Gull, and there was no possibility of confusing it with the small dark areas at the wing-tips of *L. g. kumlieni.*

I saw another Thayer's Gull on February 3; this was attracted to offal when the ship was stationary in slob ice at 49°10′N 59°48′W. I had probable sightings from the moving ship on February 5, of single birds at 47°35′N 59°25′W and 47°32′N 59°11′W, south west of Port-aux-Basques. On the same date, I estimated about 25 Herring Gull-type birds among the thousands of gulls around the fish plant in Rose Blanche harbour (47°36′N 58°42′W); some of these were certainly Thayer's Gulls, but counts were not possible.

It seems likely that a small part of the Thayer's Gull population — perhaps that breeding at the eastern edge of its range — winters on the Atlantic and not the Pacific coast.

I am grateful to Dr. W. E. Godfrey and Dr. D. E. Sergeant for their comments; to the Director, Fisheries Research Board, St. John's, Newfoundland, for permission to work on the "Cameron"; and to R. J. Wells, Capt. G. Walters, and the ship's personnel for their help. Further details of these records have been deposited with the PIROP seabird reporting scheme (Dr. P. Germain, Université de Moncton).

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R. G. B. BROWN

Canadian Wildlife Service,
Marine Ecology Laboratory,
Bedford Institute,
Dartmouth, N.S.

Received September 7, 1971.
Accepted May 10, 1972.

A Robin "Colony" in Southern Ontario

During the summers of 1967-1970 I was working on bird damage problems in the Vineland area of the Niagara Peninsula, southern Ontario. I was impressed by the numbers of Robins, *Turdus migratorius,* which bred in the Ontario Department of Agriculture's Victoria Farm orchard at Vineland Station. The density of these birds was such that in one part of the orchard they could almost be called colonial; the centre of this "colony" shifted from year to year.

In 1967 the birds appeared to be concentrated in a tall cedar hedge and, to a lesser extent, in an adjacent plot of large cherry trees just to the west of it. In June of that year I estimated that there were 13-14 pairs of Robins breeding in the 38 acres of this "colony" area. By contrast, there were only 8-13 pairs in the remaining 67 acres of the farm, much of it made up of medium-sized fruit trees apparently suitable as Robin nest sites. During the same period there were only 6 pairs of Robins breeding in the Canada Department of Agriculture orchard at Jordan Harbour, nearby — a site similar to but about half the size of Victoria Farm. These figures suggest that Robins in the "colony" concentration were breeding at more than twice the density of birds in other orchard habitats in the Vineland area.

It might be thought that the Robins were taking advantage of safe nest sites provided by the tall cedar and cherry trees in the "colony" area. However, they began to move away from it in 1968, shifting to the southwest. In contrast to 1967, there were fewer nests in the cedar hedge and more in the large cherry plot, as well as more birds breeding in fairly small trees to the south and west of the central area. This trend continued in later seasons; the Robins practically abandoned the cedar hedge in 1969, and had mostly left the large cherry plot as well in 1970. The "colony" had probably moved to a second cedar hedge and other tall trees on private land at the southwest corner of the farm, about 100 yards away.

The densities of Robins in the "colony" area were not exceptionally large; the 0.35 nests /acre in 1967 was well below the averages of 3.5 and 1.9 nests /acre which Howell (1942) reports for very small study areas in New York State. But the interesting points are that the density in the concentration was higher than in other, similar habitat in the Vineland area, and that the concentration changed its geographical position from season to season. Taken together, these seem to satisfy one of the definitions of "colony" in Webster's Third New International Dictionary: "a distinguishable localised population within a species." Why the birds should form such a "colony" is another matter; one might speculate that they were taking advantage of an abundant fruit or animal food supply close by.

As far as I know, this behaviour has not previously been recorded for the Robin; or, indeed, for any *Turdus* species other than the Fieldfare *T. pilaris,* which regularly nests in colonies that are more discrete than that described here (Bent 1949; personal observations).

I acknowledge the field assistance of K. C. Coulthart and J. V. Dobell during this work, and the help given me by the Canada and Ontario Departments of Agriculture Research Stations at Vineland Station.

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R. G. B. Brown

Canadian Wildlife Service,
Marine Ecology Laboratory,
Bedford Institute,
Dartmouth, N.S.

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Brown Thrasher in British Columbia

On September 21, 1970 a Brown Thrasher, *Toxostoma rufum* was observed in a rural garden at West Bench, one-half mile west of Penticton, British Columbia. This is believed to be the first record of this species for British Columbia.

The bird was observed for fifteen minutes by three members of my family as it emerged from ornamental shrubbery and drank from a small garden pool. A Brown Thrasher was seen again at the same pool the following day on four occasions between 7 a.m. and 4:30 p.m. The bird was photographed on colour film with a 35mm still camera and also with a 16mm movie camera. Copies of the still photographs were submitted to the Vertebrate Museum, Department of Zoology, University of British Columbia where identification was confirmed. The photographs are on file at the above museum under catalogue number 109.

Stephen R. Cannings

20 West Bench Drive,
R.R. 1, Penticton, B.C.

Received August 26, 1971.
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Black-necked Stilt, New for British Columbia

The Black-necked Stilt (*Himantopus mexicanus*) breeds from southern Oregon and Colorado, south through Mexico and Central America to northern South America, including the West Indies. In Canada the bird has been recorded as a vagrant in Ontario, Newfoundland, and New Brunswick (Godfrey, 1966).

During the early evening of May 13, 1971, while banding shorebirds on a small freshwater marsh on Sea Island (in the Municipality of Richmond), British Columbia, Bill Anderson and Jim Biggar spotted a Black-necked Stilt feeding along the shore. In the excitement of alerting Russ Janes, Brad Watts and one writer (RWC), who were preoccupied with measuring and banding birds recently caught, the Stilt departed. An extensive search, in fading light, of nearby fields and pockets of water, was unsuccessful.

The following evening Eileen Campbell, R. W. Campbell, and Michael G. Shepard returned to the marsh, hopeful of confirming the sighting. The marsh is located in the extreme northwest corner of the Vancouver International Airport grounds. To our surprise the stilt was wading in one of the shallow ponds, picking up food items from the mud. Notes were recorded on the bird's plumage and then about ten colour photographs were taken, using a 200 mm. telephoto lens. Some slides show the stilt with the topography of the airport in the background, to substantiate the locality. Eight slides have been added to the photoduplicate file of British Columbia vertebrate records (catalogue number 168) at the Vertebrate Museum at the University of British Columbia. (See Campbell and Stirling, 1971). The stilt was not seen after May 14.

This sighting represents the first occurrence of the Black-necked Stilt in the province and on the basis of this report it can be added to the extralimital list of British Columbia birds. The nearest point in normal range is Malheur Lake in Oregon (A.O.U., 1957).

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R. WAYNE CAMPBELL
WILLIAM J. ANDERSON

Vertebrate Museum
Department of Zoology
University of British Columbia
Vancouver 8, British Columbia
Canada

Received February 21, 1972.
Accepted May 11, 1972.

Poor-will from East-central Alberta

The range of the Poor-will, *Phalaenoptilus nuttallii*, in Alberta appeared to be limited to the Cypress Hills region where several birds were heard and a single specimen was taken in 1945 (Salt and Wilk 1966; Godfrey 1966). Thus the presence of a specimen of this species on the farm of G. Hostvedt, 3.5 miles east of Lindbergh (116 miles ENE of Edmonton) is of considerable interest.

The Hostvedts had found the bird in a lethargic state on their doorstep on October 31, 1971. Upon becoming warmed in their house, it became active and was released. On November 3, it reappeared on their doorstep and as it was cold and snowing at the time the Hostvedts retained it indoors.

The Hostvedts kindly provided descriptions and photographs of this bird and these are on file in the University of Alberta Museum of Zoology. From these descriptions there can be no doubt as to the identity of the specimen. The lack of white patches in the wing and the presence of a rounded tail distinguish it from the common caprimulgid in Alberta — the common nighthawk, *Chordeiles minor*. The presence of 0.5 inch white squares on the three outermost rectrices and small size, about 8 inches in length, distinguish it from the Whip-poor-will, *Caprimulgus vociferus*, which might be more likely to occur in that region of Alberta because of its more northern distribution to the east in Saskatchewan (Godfrey 1966).

At the time of writing (January 3, 1972), the bird was still alive in the home of the Hostvedts. They are feeding it a mixture of ham-

burger and barley chop which they claim is to its liking. The bird "spends most of his time sitting under the heater," makes sounds "like a clucking hen when content," and uses a pan of dry sand in which to "dust bath" (Hostvedt, pers. comm.).

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D. A. Boag

The University of Alberta
Edmonton 7, Alberta
Canada.

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The Purple Cliff-brake, *Pellaea atropurpurea* (L.) Link, in Western Quebec

Abstract. Four new stations for *Pellaea atropurpurea* (L.) Link were found in Gatineau Park, Gatineau County, Quebec. The sites are described in detail and compared with those for collections of the species from elsewhere in Eastern Canada. Gatineau Park specimens match plants from Campbell's Bay much more closely than plants from Cap Tourmente. Campbell's Bay and Cap Tourmente are the only other known locations for the species in Quebec. One of the colonies may be the largest, most robust in Canada for this species.

During a continuing survey of cliffs in the Ottawa-Hull District, we examined portions of the Escarpment along the southern edge of the Canadian Shield which we felt were suitable for evergreen cliff ferns. These searches were conducted in March and April, in the knowledge that winter conditions would eliminate much of the problem of obscuring herbaceous vegetation, thus permitting a more thorough search.

Pellaea atropurpurea (L.) Link, the Purple Cliff-brake, was found at four sites. A description of these stations, all within Gatineau Park, Gatineau County, Quebec, follows.

Site 1. Latitude 45° 29′ 24″,
Longitude 75° 52′ 42″
Elevation: 675 ft. March 29, 1972.

Eight clumps were found, two of which were robust, with fronds 12″ to 14″ long. All were erect, growing in ledge fissures of a crumbly metamorphic rock which had an obvious calcareous element. The more robust clumps were growing in a 1″ to 2″ accumulation of eroded debris. The plants were somewhat shaded by several trees of Hackberry (*Celtis occidentalis* L.) and Red Oak (*Quercus rubra* L.). Associated common species included *Juniperus virginiana* L., *Draba cana* Rydb., and *Celastrus scandens* L.

Site 2. Latitude 45° 29′ 20″,
Longitude 75° 52′ 26″
Elevation: 730 ft. April 23, 1972.

Seven clumps were found growing in vertical crevices of calcareous rock, 1 ft. to 3 ft. above the talus of a 40 foot cliff. All were robust and erect, growing in several inches of eroded debris. The station was shaded by Red Maple

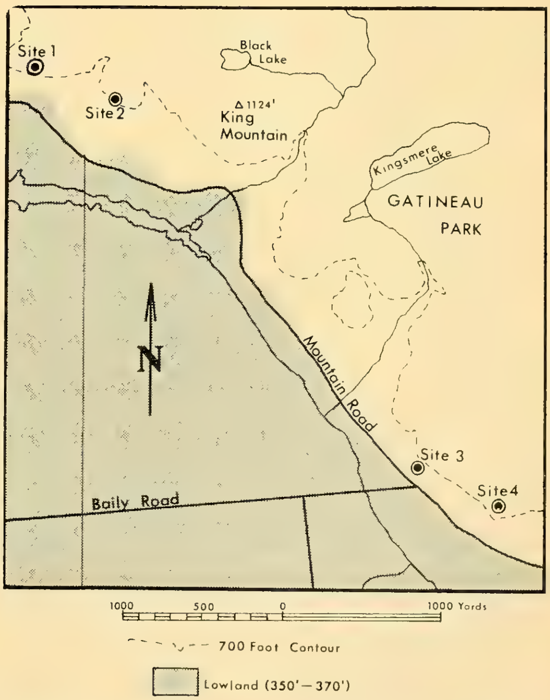

Figure 1. Location of Gatineau Park stations of *Pellaea atropu purea*. The Mountain Road marks the southern boundary of Gatineau Park.

by D. F. Brunton

(*Acer rubrum* L.), Red Oak and Ironwood (*Ostrya virginiana* (Mill.)K. Koch). Associated common plants included *Draba cana* Rydb. and *Woodsia ilvensis* (L.)R. Br.

Site 3. Latitude 45° 28′ 13″,
Longitude 75° 51′ 00″
Elevation: 600 ft. April 13, 1972.

P. *atropurpurea* was very common at this station. Throughout the face of a calcareous cliff which measured approximately 30 ft. high by 50 ft. wide, erect, robust clumps were found in any fissures which contained enough debris for the plants to take root. In all, approximately 40 clumps were noted at this station. Shelter conditions varied from plants growing on mostly exposed ledges, to others springing up from within *Lonicera* bushes. Associated common species included *Lonicera canadensis* Bartr., *Celastrus scandens* L., *Betula papyifera* Marsh. and *Ribes lacustre* (Pers.)Poir.

Site 4. Latitude 45° 28′ 07″,
Longitude 75° 50′ 10″
Elevation: 750 ft. April 13, 1972.

One small, erect clump was found in a thin, debris-filled fissure about 3 ft. above the talus of a 50 foot cliff. Though the fissure was in acidic precambrian rock, the debris which filled it resulted from erosion of the calcareous rock above. The plant was well shaded by surrounding Red Oak and Basswood (*Tilia americana* L.). There is abundant evidence of active rock slippage throughout the cliff-face. Associated common species included *Cystopteris fragilis* (L.)Bernh. and *Dryopteris marginalis* (L.)Gray.

Discussion

P. *atropurpurea* is known from only two other locations in Quebec, three stations in the Cap Tourmente area of Montmorency County and one station at Campbell's Bay, Pontiac County (Rigby and Britton 1970). The latter station (exact site unknown) is approximately 40 miles northwest of the Gatineau Park specimens, and is on an extension of the same escarpment. Britton, Legault and Rigby (1967) state: "Specimens which we have seen from Campbell's Bay have the larger more divided fronds that are characteristic of many specimens from the United States whereas the Cap Tourmente specimens . . . are smaller, less divided and resemble closely poorly developed material . . . collected in Bruce County, Ontario." The clumps from Gatineau Park agree closely with Campbell's Bay specimens at DAO.

The robustness of Western Quebec material is probably a reflection of the rich, protected situations in which they are found. This type of habitat is in marked contrast with the habitats described from such areas as the Niagara Escarpment in Ontario, where poorly developed specimens typically occupy small cracks and seams in exposed faces of dry limestone.

Further searches along the escarpment between Gatineau Park and Campbell's Bay may well produce additional records, though such areas do not appear to be common along the primarily acidic cliffs.

The Gatineau Park collections constitute the first records of the species in the Ottawa-Hull District (W. J. Cody, pers. com.). Site 3 may well be the largest, most robust colony of *Pellaea atropurpurea* in Canada. Specimens from all four stations have been preserved in the personal herbarium of D. F. Brunton, (collection numbers 475, 480, 447 and 446) from Sites 1, 2 and 3 in DAO, and from Site 3, in CAN.

Acknowledgements

Our thanks to David White of Ottawa for his assistance in the April 23rd survey. For permission to examine specimens in DAO, we wish to thank the curator, W. J. Cody.

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J. DONALD LAFONTAINE

916 Innswood Drive,
Ottawa, Ontario K2A 3S1

DANIEL F. BRUNTON

Rideau Valley Drive,
R.R. 3, Manotick, Ontario

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IN MEMORIAM: HERBERT GROH

P. M. TASCHEREAU

Curator of Botany, Nova Scotia Museum, Halifax, N.S.

With the death of Herbert Groh on December 8, 1971, an era of Canadian botany ended. A pioneer in the study of the weed flora of Canada, Mr. Groh was a living link with such early Canadian plant scientists as John Macoun, James Fletcher and William Saunders.

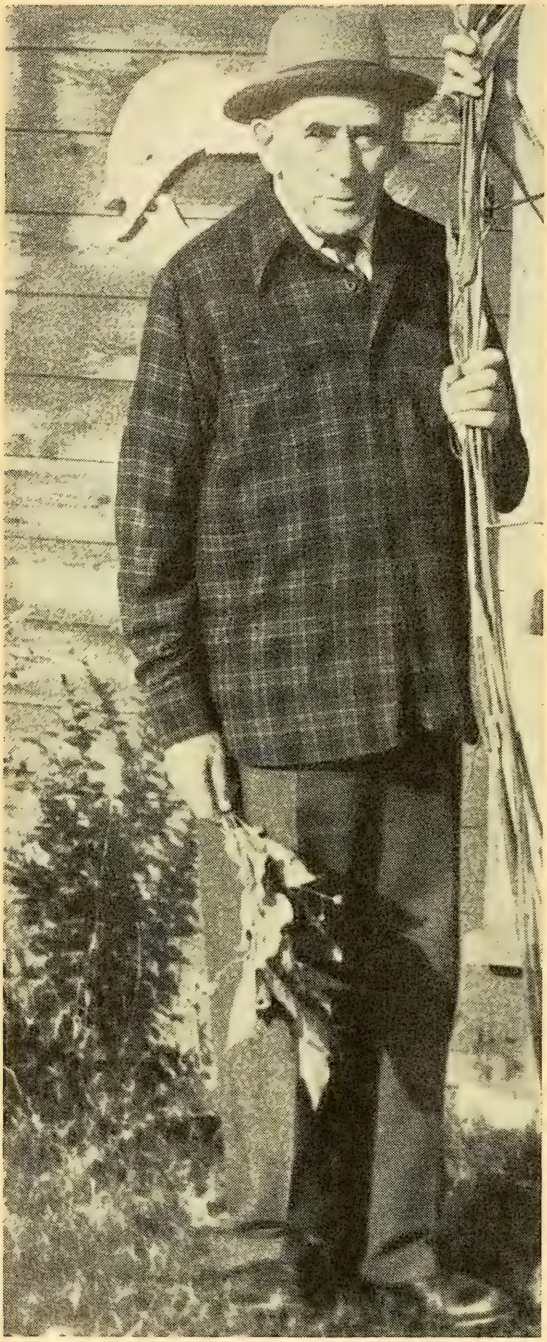
Herbert Groh is known to Canadian botanists primarily in connection with weeds, and it is largely because of his early work on these plants that Mr. Groh's name is scattered on the pages of Canadian floras from Nova Scotia to British Columbia. The first report of the Canadian Weed Survey, written by Herbert Groh, was issued in 1942. This work developed from the lists and collections of weeds made by Mr. Groh while travelling across Canada as a Plant Disease Inspector for the Federal Department of Agriculture. The work culminated with the seventh report prepared with Dr. Clarence Frankton. Compiled from 4,687 survey lists made by Mr. Groh, this report summarizes in tabular form the distribution of 1200 species of weedy plants in Canada.

More than for his botanical accomplishments, this quiet, very modest, unassuming man, will be remembered as an inspirer of youth. While with the Division of Botany and after his retirement, Herb Groh worked with youth. Beginning with a Sunday school class, his involvement spread to include the Y.M.C.A., summer boys' camps, the Ottawa and District Boys' Work Board, and the Macoun Field Club. He taught young people to observe and enjoy nature, to appreciate the world around them, and to develop interests that would enrich them for the rest of their lives. His book was the out-of-doors; his precepts, the example of his enthusiasm and of his own sterling character; his secret, the interest he took in each individual with whom he had contact. In numerous loose-leaf volumes he recorded by means of photographs, newspaper clippings, notes and correspondence, the progress in life of every youth with whom he had worked.

Mr. Groh published more than 200 articles in the form of scientific papers, notes, reviews, and essays related to his youth work. In his booklet: *Natural History for Young Campers,* he set forth some of the techniques he so effectively used in interesting young people in natural history. His major scientific publications were the *Canadian Weed Survey Reports* (numbers 6 and 7 with C. Frankton) and "*Prunus* in Eastern Canada" (with H. A. Senn).

Mr. Groh's ancestors were from Switzerland. They came to Pennsylvania and thence to Canada where they settled on land a mile from the later town of Hespeler near Preston in Waterloo County, Ontario. It was here on this farm that Herbert Groh was born March 7, 1883, to Anson Groh and Lovina Bechtel on their first wedding anniversary. During the next ten years, ten other sons and daughters were added to the Groh family.

Herb's training in natural history began early. As a boy he ranged his father's orchards and fields, with a younger sister as follower, improvising names for plants and animals that were new to him. He raised silk-worms as a hobby, feeding them from a mulberry tree that grew at the front door. Anson Groh read with keen interest every scientific paper on farming that came out of the young agricultural college at nearby Guelph. With Herb's help he put into practice the findings of this institution for improved agriculture. Anson began recording the milk production of the small but ever enlarging herd on the farm. For 25 years Herb carried on this project while he was on the farm, and with the help of others while he was away. He eventually summarized and charted the voluminous data from these records for a



Herbert Groh: Botanist and Naturalist

1883-1971

scientific publication. The milk records later became the inspiration for numerous articles he wrote in the farm press to help other farmers learn to distinguish the top producers from the mere boarders.

While a senior at the Ontario Agricultural College, Mr. Groh met James Fletcher and approached him with a question concerning the identification of a new weed he had found occurring in alfalfa seedings. As it happened, the same plant had been coming to Dr. Fletcher from correspondents across Canada and he manifested the keenest interest in yet another record. He was able to name it — *Eruca sativa* — and urged Mr. Groh to write a note on his experience with it for *The Ottawa Naturalist.*

In 1908 Mr. Groh graduated from the University of Toronto's Ontario Agricultural College with a Bachelor of Science in Agriculture. During the same year he became assistant botanist on the staff of the Horticulture Experimental Station at Vineland, Ontario. The following year, Dr. Fletcher, in need of an assistant, persuaded Mr. Groh to join him at the Central Experimental Farm in Ottawa.

When Groh arrived in Ottawa, Fletcher introduced him to the staff of the farm, took him into his home for the first meal and arranged for his assistant, entomologist Arthur Gibson, to find him suitable accommodation and to show him around the town. The Saturday following his arrival, Herb joined Fletcher and a friend for a day of canoeing on Dow's Lake in search of aquatic plants. Unfortunately, Herb's association with Fletcher was short. Dr. Fletcher died some months after Mr. Groh took up his position in Ottawa. As a result, Herb frequently turned to the Macouns for help in identifying troublesome plants and during the next three winters he saw much of Professor John Macoun. Professor Macoun, during the winters of 1910-1911, was engaged steadily on his Flora of the Ottawa District. He relied on Mr. Groh to provide him with the herbarium records (mainly of Fletcher's collecting) from the Experimental Farm. In 1910 Mr. Groh became treasurer of the Ottawa Field-Naturalists' Club. A year later, despite requests from the Macouns to join them at the

National Herbarium, the lure of the land took him back to the family farm near Hespeler. Before he departed, William and Mrs. Saunders had a farewell dinner for him.

From 1911 to 1921 Mr. Groh managed the 335 acre home farm; however, he was far from divorced from scientific pursuits. He introduced to his farm operations a share in the investigations of his former colleagues and a number of the experiments underway at the Ontario Agricultural College. There were plot tests of crop varieties, trials of little known novelties, experiments with fertilizers and the keeping of weather records with rain gauge and thermometer. He continued the systematic daily recording of the milk yield from all the cows in the herd. On an otherwise unproductive hillside, Mr. Groh and his brother planted trees. The trees are now a small forest stand along Highway 401. During these ten years Mr. Groh was actively involved in the life of the community. In 1915 he became president of the Ontario Agricultural and Experimental Union, Guelph, Ontario. This organization distributed superior crop varieties to farmers for testing, and invited such men to address them as B. E. Fernow on forestry, and L. H. Bailey on agriculture. In 1919, Mr. Groh became secretary of an early co-operative, the Maple Grove Farmers Club of Preston, Ontario. The local newspaper of the time contained some fiery correspondence signed "Herbert Groh, Secty., Maple Grove Farmers Club", defending the club against an attack in print made by a local merchant. In 1920 Mr. Groh became a charter member of the Agricultural Institute, of which he was later to be made a life member. At this time he also became secretary treasurer of the new municipal telephone system at Preston.

After leaving Ottawa, Mr. Groh maintained contact through correspondence with his former chief, Dominion Botanist Hans T. Güssow. He visited Mr. Groh on the farm, and in the autumn of 1912, when the Department of Agriculture was in need of inspectors to track down the newly discovered potato canker and powdery scab, secured Mr. Groh's temporary services for work in the Maritime Provinces. In 1920, Dr. Güssow arranged similar work for him in New Brunswick. While not employed by the Department, Mr. Groh was actively co-operating in botanical observations and in the tests Dr. Güssow was conducting on broom corn. Thus, in 1921, during a time when Mr. Groh was obliged to take a rest from particularly strenuous work on the farm, he was persuaded to accept a six-month appointment as Plant Disease Inspector in the newly potato conscious province of Manitoba. This appointment was twice renewed until, at the end of eighteen months, a regular position was arranged for him in Ottawa. The expected return to the farm never materialized.

It was during this time in Manitoba as a Plant Disease Inspector that Mr. Groh evolved a unique scheme for recording his observations on weeds. When later recalled to Ottawa, he was allowed to put it into practice. This was the beginning of the weed surveys at which he was to work for the following twenty-five years. The seven reports of the Canadian Weed Survey and numerous scientific and popular publications on weeds were the fruit of this devotion.

Any memories of Mr. Groh would be incomplete if they did not mention the deeply religious side of his character. He held the view that an evolution of selfless love, fellowship with man and with God is the essence of life. Shortly after returning to Ottawa, he joined a mission church in the west end of that city. Not content to be merely a church-goer, he was soon actively involved as the Sunday school teacher of a group of boys. Here began a long career of selfless work with youth. From 1924 to 1939, Mr. Groh was Mentor of a Trail Rangers group; in 1925 he extended his work to the Y.M.C.A. and began instructing young campers in natural history at Shirleys Bay Y. Camp.

In 1933, he married Mildred M. Krupp of Amyot, Ontario, who enthusiastically joined with him in church and youth work.

In 1938, Mr. Groh was chairman of the committee that launched Woodland Camp. Under his leadership, and with the assistance of geologist D. C. Maddox, this boys' camp

soon became renowned for the quality of its natural history instruction and the calibre of its leaders. Nature lore for young people was too worthwhile to be confined to the summer. Thus, in the fall of 1948, together with W. K. W. Baldwin, Mr. Groh founded the Macoun Field Club for junior naturalists. Sponsored by the Ottawa Field-Naturalists' Club and the National Museum of Canada, this club today has about ninety active members and a growing alumni of scientists, teachers, and enthusiastic naturalists.

Mr. Groh's association with the Ottawa Field-Naturalists' Club began in 1908 when he joined the Macouns, James Fletcher, Arthur Gibson and others in the group at the time, and two years later was elected treasurer. He was the unofficial chronicler of the club and its more illustrious members. This historical and biographical writing began in 1909 when with Arthur Gibson he compiled a list of the published writings of James Fletcher for a memorial issue of *The Ottawa Naturalist*. Through the years, he followed with a series of publications containing biographic sketches, recollections or memorials of club members, and in 1956 he published a short history of the club. When he returned to Ottawa after his time on the home farm, Herb again became active in the Ottawa Field-Naturalists' Club and, from 1935 to 1937, served as its president.

Mr. Groh was a Fellow of the American Society for the Advancement of Science, Honorary Member of the Ottawa Field-Naturalists' Club, Honorary Member of the Entomological Society of Canada, Honorary Member of the Agricultural Institute, Honorary President of the Ottawa and District Boys' Work Board. The following plants are named in honor of Herbert Groh:

Claviceps Grohii Groves, Mycologia 35: 608, 1943

Scutellaria lateriflora L. var. *Grohii* Boivin, Annales de l'ACFAS 19: 96, 1963

Hieracium × *Grohii* Lepage, Naturaliste Canadien 87: 100, 1960
(Lepage in Naturaliste Canadien 98(4): 671, 1971 places this name as a synonym of *H. sabaudum* L.)

Saponaria Vaccaria L. f. *Grohii* Boivin, Naturaliste Canadien 93: 645, 1967.

Until a few years before his death, Mr. Groh was active on the Council of the Ottawa Field-Naturalists' Club and served each summer as naturalist at Woodland Boys' Camp. What was said of James Fletcher is true of Herbert Groh: "Others will take up the work he initiated and organized, and their way will be smoother and easier by reason of his unselfish and unremitting toil and watching."

THE PUBLISHED WRITINGS OF HERBERT GROH

Mr. Groh prepared a rough, hand-written list of his publications, the basis for the compilation below. Details have been filled in where the publications have been readily available, but no attempt has been made to complete or verify data on articles that appeared in newspapers or popular works. The list is incomplete: Mr. Groh himself mentions that there were some of his writings that he had misplaced. In compiling the list, I omitted a few articles for which he could not determine the date of publication or the source.

I am grateful to the library staff of the Plant Research Institute, Ottawa, for completing the references to articles published in the *Ottawa Naturalist* and its successor, the *Canadian Field-Naturalist,* and several other journals and departmental publications.

1902

The Cabbage Butterfly and its Parasites. Farmer's Advocate, London, Ontario.

A Cheap Corn Marker. Farmer's Advocate, London, Ontario.

1903

Notes on Natural History Topics. Family Herald and Weekly Star, Montreal, Quebec.

Injurious Insects. Maritime Farmer, Sussex, New Brunswick.

1904

Bindweed and Black Bindweed. Farmer's Advocate, London, Ontario.

The Fall Webworm. Maritime Farmer, Sussex, New Brunswick.

Growing Clover on Light Land. Maritime Farmer, Sussex, New Brunswick.

Advantages of Farm Milk Records. Maritime Farmer, Sussex, New Brunswick.

1905

Tumbleweed. Farmer's Advocate, London, Ontario.

Nature Study and Birdsnesting. Farmer's Advocate, London, Ontario.

Monthly Correspondence (starting July). Farmer's Advocate, London, Ontario.

Collect Weed Seeds This Fall. Farmer's Advocate, London, Ontario.

Shallow Plowing the Best. Farmer's Advocate, London, Ontario.

Experience with Milk Records. Maritime Farmer, Sussex, New Brunswick.

1906

Lessening Labour on Ontario Farms. Farmer's Advocate, London, Ontario.

One View on the Stable Question. Farmer's Advocate, London, Ontario.

1907

Another Locality for *Eruca sativa*. Ottawa Naturalist 21(8): 161.

Inflorescence of Canada Thistle (*Cnicus arvensis*). Ontario Natural Science Bulletin 3: 41-42.

Anatomical Nomenclature (A Book Review). Canadian Entomologist.

The Family Aleyrodidae. Report Ontario Entomological Society.

Two Insects Affecting Red Clover Seed Production (with T. D. Jarvis). O.A.C. contribution to the Press, Guelph, Ontario.

Summary of Fumigation Experiments. Annual Report, Ontario Agricultural College, Guelph, Ontario.

1908

Foreword (as Assistant Editor). Ontario Natural Science Bulletin, Guelph, Ontario 4: 3-4.

The Codling Worm. Farmer's Advocate, London, Ontario.

The Passing of the Forest in Relation to the Flora. O.A.C. Review, Guelph, Ontario.

Something Worth While. Gospel Herald, Scottdale, Pa.

1909

The Published Writings of Dr. Fletcher (with A. Gibson). Ottawa Naturalist 22(10): 227-233.

Meeting of the Botanical Branch. Ottawa Naturalist 22(12): 265-266.

Snake Behaviour. Ottawa Naturalist 23(3): 58-59.

The Tragic Side of Bird Life. Ottawa Naturalist 23(7): 131.

Spectres of the Plant World. O.A.C. Review. p. 530-533.

What About the Farm? Christian Monitor, Scottdale, Pa.

Plant Diseases. Christian Monitor, Scottdale, Pa.

Consolidation of Rural Schools in Ontario. The Farm and Dairy and Rural Home, Peterboro, Ontario.

Preliminary List of the *Crataegi* of the Ottawa District. Ottawa Naturalist 24(7): 126-128.

1910

Bartonia virginica in Quebec. Ottawa Naturalist 23 (11): 211.

Another Case of Natural Grafting. Ottawa Naturalist 24(3): 64.

The Clarke Nutcracker in Manitoba. Ottawa Naturalist 24(9): 168.

The Amelanchiers or Juneberries. Ontario Natural Science Bulletin, Guelph, Ontario 6: 51-55.

Prevention as a Factor in Weed Control. Central Canada Citizen, Ottawa, Ontario.

The Soil. Christian Monitor, Scottdale, Pa.

1911

A New Host for *Claviceps*. Mycologia 3: 37-38.

A Forest Flora in the Making. Ottawa Naturalist 25: 16-18.

A Word Regarding Rhodes Grass. Weekly Witness, Montreal, Quebec.

Protect the Birds. Family Almanac, Scottdale, Pa.

1912

The Bartramian Sandpiper Breeds near Guelph, Ontario. Ontario Natural Science Bulletin 7: 38-40.

Giving the Hoe a Holiday. Weekly Budget.

Value of Milk Records in Herd Improvement. Weekly Budget.

Attracting the Birds to the Farm Home. The Daily Reporter, Galt, Ontario.

1913

The Bartramian Sandpiper. Ontario Natural Science Bulletin 8: 52.

Another Way To Keep the Boy on the Farm. Christian Monitor, Scottdale, Pa.

1915

The Road to Dairy Herd Improvement. Farm and Dairy and Rural Home. Peterboro, Ontario.

The Importance of the Clovers in Farming. Christian Monitor, Scottdale, Pa.

1916

Presidental Address. Report Ontario Agricultural and Experimental Union, Guelph, Ontario.

Intelligent Cutting of the Farm Woodlot. Canadian Countryman, Toronto, Ontario.

1917

Objects to Life Insurance. Farmer's Advocate, London, Ontario.

The School Garden. The Daily Reporter, Galt, Ontario.

1918

Review of Books for the Farmer. Christian Monitor, Scottdale, Pa.

1919

A Robin's Mishap. Canadian Field-Naturalist 33(2): 40.

After Harvest Cultivation. Canadian Countryman, Toronto, Ontario.

Our Milk Supply. Preston Progress, Preston, Ontario.

1920

Puss in a Sparrow Chase. Canadian Field-Naturalist 34(1): 18.

1921

A Milk Sheet Protector. Farmer's Advocate, London, Ontario.

A Canadian Potato Belt. Youths' Christian Companion.

1922

Lean Kine of Cedarhurst. Farmer's Advocate (Christmas Number: London and Winnipeg editions).

Check List of Manitoba Flora (with V. W. Jackson and J. F. Higham). Manitoba Departmental publication, Winnipeg, Manitoba.
Contributions (unsigned) 1922-1939. Reports of Dominion Botanist.

1923
Potato Seed Treatment Tests in Manitoba (wi h G. R. Bisby and J. F. Higham). Scientific Agriculture, Ottawa, Ontario 3: 219-221.
A Survey of Weed Control and Investigation in Canada. Scientific Agriculture, Ottawa, Ontario 3: 415-420.
Canadian Weed Survey — Seasonable Hints. Department of Agriculture Publication, Ottawa, Ontario.
After Harvest Work Against Weeds. O.A.C. Review, Guelph, Ontario.
The Trees of Cedarhurst. O.A.C. Review, Guelph, Ontario.
Preliminary Weed Survey of Ontario. Report Ontario Agricultural and Experimental Union, Guelph, Ontario.
The Smelt Fishers of the Tabusintac. Youths' Christian Companion.

1924
Salamanders Lost Strayed or ?. Canadian Field-Naturalist 38(8): 159.

1925
Stachys germanica L. in Canada. Canadian Field-Naturalist 39(4): 84-85.
Wintering Over of Weeds — Seasonable Hints. Department of Agriculture Publication, Ottawa, Ontario.
The True Story of Another Angel. The Christian Exponent, Wooster, Ohio.

1926
Coast Jointweed (*Polygonella articulata* (L.) Meisn.) in the Ottawa District. Canadian Field-Naturalist 40(1): 19-20.
Celastrus scandens L. Sixty Feet High. Canadian Field-Naturalist 40(4): 87.
A Quarter Century of Herd Improvement. Scientific Agriculture 6(8): 280-282.
Weeds as Neighbours. Canadian Homes and Gardens, Toronto, Ontario.
Bread Upon the Waters. Youths' Christian Companion.
1926-1927. The Dominion Weed Survey. Report, Quebec Society for Protection of Plants. 19th Annual Report 43-46.

1927
The Storied Trees of Cedarhurst. Canadian Homes & Gardens, Toronto. 4: 29, 69, 70, 72.
The Spread of *Axyris amaranthoides* L. Canadian Field-Naturalist 41(9): 202-203.
Smooth Perennial Sow Thistle at Ottawa. Canadian Field-Naturalist 41(8): 188.
Western Ragweed to the Eastward. Canadian Field-Naturalist 41(9): 202.
Asclepias tuberosa L. — in the Ottawa District. Canadian Field-Naturalist 41(9): 202.
A Prince Edward Island Weed Survey. Scientific Agriculture, Ottawa, Ontario 7: 388-395.
Letter to a Doubter of the Old Old Story. The Christian Exponent, Wooster, Ohio.

1928
Hardhack and its Eradication. Department of Agriculture publication, Ottawa, Ontario.
Corn Borer and Mugwort. Ontario Farmer. 25(10): 7.

1929
Gumweed (*Grindelia squarrosa* (Pursh) Dunal) in Ontario. Canadian Field-Naturalist 43(5): 106-107.
Western Ragweed Farther East. Canadian Field-Naturalist 43(6): 137.
Some Little Noticed Weeds — Seasonable Hints. Department of Agriculture publication, Ottawa, Ontario.
Poisonous Wild Fruits. O.A.C. Review, Guelph, Ontario.

1930
Concerning the Burdock Seed Gelechiid. Canadian Field-Naturalist 44(1): 21.
Grande Prairie Weeds: a provisional review. Department of Agriculture Publication, Ottawa, Ontario. Pamphlet No. 117.
Poison Ivy (*Rhus toxicodendron* L.). Department of Agriculture Publication, Ottawa, Ontario. Circ. No. 75.
Horsetail a Horse-Poisoning Weed. Department of Agriculture Publication, Ottawa, Ontario. Circ. No. 74.

1931
Hoary Cress (*Lepidium Draba* L.) at Ottawa. Canadian Field-Naturalist 45(6): 149.

1932
Clasping-leaved Cress or Peppergrass (*Lepidium perfoliatum* L.) in Canada. Canadian Field-Naturalist 46(2): 48-49.
Youth's Christian Companion. Canadian Mentor, Toronto, Ontario.
Wild Boynimals I have Known — Around a Campfire. Youths' Christian Companion.
Bobby K-. Youths' Christian Companion.

1933
Lilium umbellatum near Ottawa. Canadian Field-Naturalist 47(3): 59.
Some New Plant Records for Canada. Canadian Field-Naturalist 47(1): 10.
Some Recently Noticed Mustards. Scientific Agriculture, Ottawa, Ontario 13: 722-727.

1934
Erucastrum gallicum — a Sly Intruder. Canadian Field-Naturalist 48(1): 10-11.
Ajuga genevensis L. — Erect Bugle in Canada. Canadian Field-Naturalist 48(6): 102.
What's a Hike. A Description of an Interesting Outing with a Group of Boys. Youths' Christian Companion, p. 191-192.

1935
Leafy Spurge — *Euphorbia Esula* or *virgata?* Scientific Agriculture, Ottawa, Ontario 15: 701-703.
Dog Mustard, *Erucastrum gallicum* — extention of known range. Quebec Society for Protection of Plants. 27th Annual Report. 65-67.

1936
Creeping Yellow Cress. A Weed in Process of Entrenchment. Scientific Agriculture 16: 331-334.

Chenopodium polyspermum at Ottawa. Canadian Field-Naturalist 50(3): 53.
Upland Plover in Vicinity of Ottawa. Canadian Field-Naturalist 50(3): 53.
1937
Peace-Athabaska Weeds, A Reconnaissance Appraisal. Department of Agriculture, Division of Botany, Experimental Farms Branch Publication 556, Technical Bulletin 7.
Poison Ivy. Department of Agriculture, Ottawa, Ontario Publication 564, Circ. 120 (Rev. Circ. 75).
Plants Responsible for Hay Fever. Department of Agriculture, Ottawa, Ontario Publication 584. Circ. 127.
1938
William Herriot, Botanist. Canadian Field-Naturalist 52(2): 28-29.
List of Grasses (Gramineae) of the Ottawa District (with W. G. Dore) Canadian Field-Naturalist 52(4): 53-55.
Number of Species as Evidence of Pasture Improvement. Scientific Agriculture, Ottawa, Ontario 18: 653-655.
1939
Recent Range Extensions for Plants. Canadian Field-Naturalist 53(3): 39-40.
1940
Chenopodium polyspermum L. in Canada. Canadian Field-Naturalist 54(4): 58.
Hoary Cresses in Canada. Scientific Agriculture, Ottawa, Ontario 20: 750-756.
Turkestan Alfalfa as a Medium of Weed Introduction. Scientific Agriculture, Ottawa, Ontario 21: 36-43.
Turkestan Alfalfa and Weed Introduction — Press Release. Department of Agriculture Publication, Ottawa, Ontario.
Prunus in Eastern Canada (with H. A. Senn). Canadian Journal of Research, Ottawa, Ontario 18: 318-346.
The Ragweed Situation in Eastern Canada in Relation to Hay Fever. (with W. H. Minshall). Canadian Medical Association Journal 43: 258-260.
1941
Range Extensions for Some Crucifers. Canadian Field-Naturalist 55(4): 54-55.
The Distribution of Bracken in its Possible Relation to Bovine Haematuria in B.C. Scientific Agriculture, Ottawa, Ontario 21: 703-710.
Distribution in Ontario of *Dracocephalum thymiflorum*. Torreya 41: 187-188.
Dodder (with H. A. Senn). Canada Dept. Agric., Ottawa. Special Pamphlet. 55.
1942
Hackberry in the Ottawa District. Canadian Field-Naturalist 56(8/9): 130.
Perennial Sow Thistle and its Smooth Variety in Canada. Scientific Agriculture, Ottawa, Ontario 23: 127-130.
Wild Boynimals I have Known. Buster A----. Canadian Mentor, Toronto, Ontario 24: 4.
Canadian Weed Survey First Report 1942. Canada Department of Agriculture, Science Service, Division of Botany & Plant Pathology, Ottawa.
1943
Notes on Common Milkweed. Scientific Agriculture, Ottawa, Ontario 23: 625-632.
Variation and Abnormality in Common Milkweed (*Asclepias syriaca* L.). Canadian Field-Naturalist 57(6): 114.
Tenderfoot Teacher. Canadian Mentor, Toronto, Ontario.
Harvest of the Years. Canadian Mentor, Toronto, Ontario.
1944
Milkweed Extremes. Canadian Field-Naturalist 58(1): 22.
Early Hooker Plant Ranges Restored. Canadian Field-Naturalist 58(1): 17-18.
Potamogeton crispus L. in Alberta. Canadian Field-Naturalist 58(4): 126.
Additional Grasses for Ottawa List (with W. G. Dore). Canadian Field-Naturalist 58(6): 193.
The Riot at Ephesus. Canadian Mentor, Toronto, Ontario.
Canadian Weed Survey Second Report 1943. Canada Department of Agriculture, Science Service, Division of Botany & Plant Pathology, Ottawa.
1945
A Milkweed Survey in Ontario and Adjacent Quebec (with W. G. Dore). Scientific Agriculture, Ottawa, Ontario 25: 463-481.
Linum catharticum in Ontario. Rhodora. 47(563): 362-363.
1946
More *Impatiens Roylei* in Canada (with E. G. Anderson). Canadian Field-Naturalist 60(5): 116.
Tragopogons as Weeds in Canada. Scientific Agriculture, Ottawa, Ontario 26: 1-6.
Canadian Weed Survey Third Report 1944. Canada Department of Agriculture, Science Service, Division of Botany & Plant Pathology, Ottawa.
1947
Hackberry in and Adjacent to the Province of Quebec. Canadian Field-Naturalist 61(4): 141-142.
Canadian Weed Survey Fourth Report 1945. Canada Department of Agriculture, Science Service, Division of Botany & Plant Pathology, Ottawa.
1948
An Uphill Trail. Canadian Mentor, Toronto, Ontario.
Vicia sepium L. — in Canada. Rhodora.
Discussion of Weed Program. Report, Meetings of Eastern Canada Weed Workers, Ottawa, Ontario.
Canadian Weed Survey Fifth Report 1946. Canada Department of Agriculture, Science Service, Division of Botany & Plant Pathology, Ottawa.
1949
Plants of Clearing and Trail between Peace River and Fort Vermillion, Alberta. Canadian Field-Naturalist 63(4): 119-134.
An Indian Ice Pick from the Ottawa District. Canadian Field-Naturalist 63(1): 41-42.
Weed Surveys in Canada (with C. Frankton). Agricultural Institute Review, Ottawa, Ontario 4(2): 150-152.
Notes from the Macoun Field Club. Ottawa Field-Naturalists Club Newsletter, Ottawa, Ontario 2: 3, April 26; 3: 2, August 10; 4: 2-3, October 18.

Canadian Weed Survey Sixth Report 1947 (with C. Frankton). Canada Department of Agriculture, Science Service, Division of Botany & Plant Pathology, Ottawa.
Canadian Weed Survey Seventh Report 1948 including cumulative index to reports 1-7 (with C. Frankton). Canada Department of Agriculture, Science Service, Division of Botany & Plant Pathology, Ottawa.
1950
Milkweed Caterpillars. Ottawa Field-Naturalists Club Newsletter, Ottawa, Ontario 7: 6, August 15.
Macoun Field Club Two Years Old. Ottawa Field-Naturalists Club Newsletter, Ottawa, Ontario 6: 7, May 15.
Bread Upon the Waters (Revised to date). Canadian Mentor, Toronto, Ontario.
1952
Some Woodchuck Lore. Ottawa Field-Naturalists Club Newsletter, Ottawa, Ontario 14: 6, May 15.
The Wildwood Tamed. The Bulletin (Federation of Ontario Naturalists), Toronto, Ontario.
Kitty Goes to Kirk. Macoun Field Club's Little Bear.
Flying Squirrels. Macoun Field Club's Little Bear.
Natural History for Young Campers. Ottawa and District Boys' Work Board, Ottawa, Ontario (15 pages, illustrated).
1953
Preview of Cunningham Island Plant Survey. Ottawa Field-Naturalists Club Newsletter, Ottawa, Ontario 19: 2-4, Winter 1953-54.
A Digger Wasp Mother. Macoun Field Club's Little Bear.
Hammer. Canadian Mentor, Toronto, Ontario.
1954
The Role of Camping in Christian Education. Canadian Mentor, Toronto, Ontario.
1955
Plants of Cunningham Island, Ottawa. Canadian Field-Naturalist 69(3): 85-93.
Let Us Now Praise Famous Men. Canadian Field-Naturalist 69(3): 75-78.
Something from Nothing. Community Courier. (reprinted in Ottawa Field-Naturalists' Club Newsletter).
Editorials, Verse, etc. Macoun Field Club's Little Bear.
Woodland Camp. Canadian Boy.
1956
A Short History of the Ottawa Field-Naturalists Club. The Bulletin (Federation of Ontario Naturalists) 74: 20-25.
A Campsite in the Making. Ottawa and District Boys' Work Board, Ottawa, Ontario (10 pages, illustrated).
1957
Professor John Macoun. The Bulletin (Federation of Ontario Naturalists) 78: 16-19.
Bees Be-Witched. Ottawa Field-Naturalists Club Newsletter, 26: 5-6, November.
Manitouwadge and Thistles to Come. The Bulletin (Federation of Ontario Naturalists) 75: 15-19.
A Birthday Book. Canadian Mentor, Toronto, Ontario.
1958
Attendance Tournament (in Reach for Mars). Canadian Mentor, Toronto, Ontario.
Little Star (poetry). Canadian Audubon.
A Third of a Century of Tuxis Camping 1924-1957. Ottawa and District Boys' Work Board, Ottawa, Ontario (31 pages, illustrated).
Blue Jay Flyway Near Ottawa. Canadian Field-Naturalist 72(4): 167.
1960
Dr. Arthur Gibson, Entomologist 1875-1959. Canadian Field-Naturalist 74(1): 1-2.
1961
David C. Maddox, 1877-1960. Canadian Field-Field-Naturalist 75(1): 1.
1962
Review of Native Plants of Eastern Canada by Montgomery. Canadian Field-Naturalist 76(3): 175-176.
1964
C.S.E.T. and the Ottawa Boys' Work Board: Reminiscence of "One Who Was There". Ottawa & District Boys' Work Board, Ottawa, Ontario (56 pages).
Right Example. Ottawa Citizen, Ottawa, Ontario.
Evolution with Faith. Onward.

Letters

The Need for Complete Protection of the Peregrine Falcon

The plight of the Peregrine Falcon has been the subject of a number of papers and letters published in the Canadian Field-Naturalist in recent years. The latest is a letter titled: "Protection of raptorial birds: boon or bust", by G. A. Fox. (Volume 85, number 4, page 335)

In that letter Fox states his opposition to complete protection in favour of "management". The "management tool" being the "valuable sport of falconry." He argues that a controlled number of nestling falcons should be removed from wild populations each year and given to falconers for safekeeping until maturity, when the birds would be released with an assumed "very low pollutant-load and thus far more likely to produce off-spring."

Fox gives the estimated mortality rate of wild Peregrines during the pre-adult stage as 66%, which he considers "the harvestable surplus that may be used for falconry." In contrast he predicts a 70% survival of birds in the hands of falconers, but he doesn't mention that this survival rate would drop drastically once the birds are set free. After a long captivity the released falcon would be accident-prone through a lack of knowledge of the things a wild Peregrine should know and through a lack of fear of man.

Because of the apparent weaknesses in the above proposal, it could simply be dismissed as the view of someone who has an axe to grind, were it not that the idea of management versus complete protection seems to spread.

There is a growing acceptance of the merits of captivity breeding, which has been hailed by falconers as the only hope for survival of the Peregrine. It is often emphasized that the birds produced will be re-introduced to the wild state, but only the most honest falconers say that breeding programs are primarily an attempt to safeguard a future source of birds for falconry purposes.

In Aubudon Magazine (Laycock, 1971) one noted falconer was quoted as stating that "to a far greater extent than most (falconers) are willing to admit", the breeding experiments are "a way of making the keeping of falcons in captivity legal and scientifically respectable."

After more than 5 years of serious attempts at breeding with Peregrines in North America, there appears to be a need for an objective appraisal. There are 2 authenticated cases of a single youngster fledged, and unverified reports of a minimum of 2 more (Nelson, 1972). While one can have a great deal of respect for the amount of dedication and work involved, and marvel at the fact that some success was had at all, when viewed in relation to the number of pairs of adult falcons held for breeding projects in Canada (10+) and the United States (30+), it is clear that up to the present time the productivity of captivity breeding compares very poorly with the reproduction of wild falcons, which according to J. Hickey (R. R. News 5-4, 129) still averages 1 young fledged per occupied nesting site.

Some breeding projects are sponsored and carried out by institutions and government agencies, such as the Canadian Wildlife Service, Patuxent Wildlife Research Centre and Cornell University. There is little reason why these official efforts should be given up, in spite of their poor records and the frequent need for more birds to replace the ones that die. But it doesn't make sense to allow every individual so inclined to have his so-called "back yard project" and use it as an excuse for keeping endangered raptors as pets.

The number of Peregrines in private hands in North America is not known. There are reports of widespread commercial dealings, legal and illegal, and much money involved (Laycock, 1971). Thacker (1971) gives importation totals into the U.S. for 1969 as 287, an increase of 149% over the previous year! Besides being robbed from the nests, Peregrines are still caught during their migrations along the Atlantic Seaboard, the Great Lakes and the Gulf of Mexico. Few figures are available. On Assateague Island the legal take was 28 birds in 1969 (Berrie, 1969).

In the past 2 years the number of registered falconers in North America doubled to about 2000 (Laycock, 1971). Nonregistered pet keepers share with them dreams of possessing one or more of their "beloved" falcons. This growing menace is in part the result of promotional activities of professional falconers, those who make their living by touring the country and showing off their pets. G. A. Fox in his letter to this Journal describes these activities as "the

only way the public will gain that respect and concern which is necessary to ensure the preservation of wildlife . . . Recently, at the Canadian National Sportman's Show in Toronto, some 5000 people were informed and many converted by such an educational display — many seeing a Peregrine for the first time." After a similar show in Edmonton a number of boys were apprehended for robbing nests and keeping hawks and owls as pets. In Alberta falconry is illegal.

While the bulk of North American Peregrines nest in Canada, much of the debate concerning the Peregrine's destiny is centred in the United States. Only the most courageous and responsible falconers side with the so-called protectionists who are finally speaking up as manifested by editorials and articles in Audubon Magazine and the California Condor. In Canada, this Journal also featured an editorial on the subject (Mosquin, 1969). In Audubon Field Notes, after a study of California Peregrines, Herman, Kirven and Risebrough (1970) state that complete protection of remaining breeding stock is essential, now that there is a reduction in the use of DDT and other chlorinated hydrocarbons, especially in the light of recovery of British Peregrines after such reductions.

Cade (1971) rejects this premise on the grounds that the English population is an insular, rather dense one, as opposed to thinly spread, in part highly migratory American populations. But the recovery of some European raptors is not restricted to Britain. In the Netherlands, migratory Kestrels (*Falco tinunculus*) and Hobby falcons (*Falco subbuteo*) are showing an encouraging comeback, while wintering Sparrowhawks (*Accipiter nisus*) and Harriers (*Circus cyaneus*) are becoming more common, after steep declines before reductions in the use of persistent pesticides (Verdonk, in litt.).

Number 3, volume 84, of the Canadian Field-Naturalist was devoted entirely to the Peregrine and carried reports on the population status in North America (Cade and Fyfe, 1970). The senior authors and the majority of 18 field investigators are falconers. R. W. Nelson reported on the Peregrines of Langara Island in the Queen Charlotte Islands, B.C. He found that the number of successful breeding pairs had increased from 3 to 5 since the previous year, while the average productivity of fledged young had also increased. This island was part of an earlier study by Blood (1969) who calculated a 66% decline since 1952. Pesticide poisoning was seen as the cause, which prompted my first letter to this Journal (Dekker, 1969) emphasizing the fact that Langara Island had taken the brunt of nest robberies by falconers during the period from 1952 to 1969, since publication of a previous study and exact disclosure of nest locations by the researcher. In the past few years the Peale's falcons of Langara Island have enjoyed effective protection. Now their former decline appears to be halted and the area was the only one on the North American continent reportedly showing an increase of breeding pairs. Nelson did not speculate on the reasons for this happy turn in events. On the contrary, in the same issue of the Canadian Field-Naturalist he makes a case for captive breeding projects, and states that total protection of the Peregrine would only hasten its extinction in North America (Nelson, 1970).

However bleak the future of the North American Peregrine may seem at the present time, the case of the Langara Island birds and the recovery of some European raptors strengthens my belief in the importance of total protection. *It is imperative that the production of wild populations be maximized.*

At present, regulations concerning the taking and keeping of Peregrines differ from province to province and from state to state. Falcons taken illegally in one part of the country, can be owned legally in another, creating opportunities for unscrupulous animal dealers. Prices are high enough to make the use of private aircraft profitable. For effective protection federal and continent-wide legislation is a necessity. It should cover the following 4 points:

1. Prohibition of the taking of nestling falcons for any purpose.
2. Safe passage for migrating Peregrines. No trapping allowed for any purpose.
3. Prohibition of the sale, importation and exportation of live Peregrines for any purpose.
4. Possession of Peregrines limited to research institutions with the proper facilities for attempting captive propagation.

The hundreds of falcons that are at present in the hands of private individuals and zoos constitute a reservoir of captive falcons which could supply the needs of research and breeding laboratories for years to come. The owners of these birds should be requested to sell their pets to the research centres at a fixed price. Alternatively, the owners of such birds should lend "their"

Peregrine during the critical months of the year to one of the centres.

In case they prefer to keep the falcon, a non-transferrable permit could be issued valid only for the life of that bird, which would have to be indelibly marked. To prevent that newly and illegally acquired nestlings would be passed off as offspring of privately held birds, or in the case of legitimate breeding success, such offspring should become the property of the agency which issued the permit.

The above points mean no less than a moratorium on the taking or using of any more Peregrines from the wild. They correspond with a resolution passed at the world meeting last year of the International Council for Bird Preservation. It recommends "to all governments, that they immediately afford complete protection of the Peregrine Falcon and its eggs, including the prohibition of the importation and exportation of live birds and their eggs for any purpose."

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DICK DEKKER

Edmonton Bird Club,
Predator Committee,
3819-112A Street,
Edmonton, Alberta.

Reviews

The Hidden Forest

By Sigurd F. Olson and Les Blacklock. The Viking Press, New York. 127 p. $14.95.

The book brings together the talents of Sigurd F. Olson, a well-known ecologist and conservationist from Minnesota, and Les Blacklock, a free-lance wildlife photographer, to present in words and pictures a series of essays describing the four seasons in the forest. Although not stated, the work describes the northern Lake States forest characterized by red, white and jack pine, black spruce, balsam fir, eastern white cedar, trembling aspen, and white birch. The Canadian counterpart to this forest is the Quetico Section of the Great Lakes — St. Lawrence Forest Region, as described in "Forest Regions of Canada".

In the introduction, Mr. Olson writes "Only by looking closely can we begin to understand and appreciate the intimate interrelationship of all living things to one another and to the earth". Accordingly, the author looks not only at the broad overview, but discusses the fungi, the lichens and the mosses, the insects, the birds and animals, as well as the herbaceous and arboraceous flora. The reader is told about the tight cones on old jack pines that burst their bonds and seeded an area after a fire, the long pendant catkins of alder, birch and aspen, clusters of dogwood with blazing red stems, the fiddleheads of ferns, the butter-yellow blossoms of marsh marigold, strawberries ripening on the forest floor, a scarlet whorl of sumac leaves, orange fungi which have taken root in an old pine stump, high clumps of mosses, like enormous pincushions, a mosquito larva jerking and wiggling to the surface of a swamp pool, geese high overhead, gabbing as they fly, a pair of loons laughing on the open water, a squirrel, stamping its feet and chattering with alarm, and partridge chicks that had hidden swiftly under dead leaves. In essence, the author eloquently describes the entire ecosystem, and the reader can well imagine himself sitting on a stump in the forest.

In addition to writing of the annual changes in the forest, consideration is also given to the changes over time, and the author discusses events that have occurred since the Ice Age as well as describing the effects of more recent factors such as wildfire and logging.

The text is accompanied by over 60 pages of excellent full-colour photographs by Mr. Blacklock. These photographs, each occupying one page, complement the written text and range all the way from general landscape views of rocky lakeshores and islands, to photographs of a red pine and a spruce forest, to views of such plant and animal species as the Indian pipe, the Cape May warbler, the bobcat, violets, and a ruffed grouse, to detailed close-ups of a moist spiderweb, lichens on aspen bark, and a portion of a blueberry plant.

In the introduction, the author clearly indicates that the book is no scientific tome; rather, it is a very easily-read guide to the forest. Notwithstanding the foregoing, the book is generally scientifically accurate; however, this forester does question whether aspen and birch are tolerant of shade, as claimed on page 45.

The book includes three or four brief essays on each of the four seasons, along with accompanying photographs. It is very attractively laid out in an 8½ by 11-inch format, and is highly recommended to anyone interested in natural history.

J. H. Cayford

Canadian Forestry Service,
Department of the Environment,
Ottawa, Canada K1A 0H3

The New York Aquarium Book of the Water World: A Guide to Fishes, Aquatic Invertebrates, Reptiles, Birds and Mammals

By W. Bridges. New York Zoological Society and American Heritage Press, New York. 1970. 287 p. 268 illustrations (104 in colour — 164 in black and white). $9.00. Available in Canada from Fitzhenry and Whiteside, Don Mills, Ont.

This book is an appreciable contribution to zoological illustration. The photographer Bill Meng and former assistant curator Erich Friese, surely succeeded in making this book very attractive with a collection of many unique photographs.

A total of 144 pages is devoted to illustrations. This represents more than half of the book. The first section discusses fishes and occupies 183 pages of the book. In this section, 78 pages are fully covered with photographs, and more than

131 of the remaining pages are half covered with photographs. Scientific information given in the text is accurate, and is written in a way that can be easily understood by the layman. Some peculiar fish behaviour is reported, making the text attractive to aquarium buffs, students in biology and biologists.

The second section deals with marine invertebrates and consists of 46 pages. Left out completely are the freshwater invertebrates like planktonic daphnia and the crayfish. However, marine coelenterates and echinoderms are well covered. The taxonomic order was not respected when the Echinodermata was placed immediately after the Coelenterata, and before the Annelida, Arthropoda and Mollusca. No mention of amphibians is made in the volume. This makes the book relatively incomplete and unity in the animal kingdom is broken. It is true that amphibians are sometimes not found in aquariums, but the most representative ones such as frogs, bullfrogs and mudpuppies, should have been included.

The third, fourth and fifth sections deal with reptiles, birds and aquatic mammals and total 30 pages about half of which consist of photographs. Certain representative species, often displayed in aquariums, are discussed, and we cannot blame the author for not having concentrated too much on the three last sections. Fish are the normal inhabitants of an aquarium, and it was logical for the author to dedicate more than two-thirds of his work to them.

Needless to say, this book represents a worthwhile photographic document, bolstered by an interesting text that is easily read and of educational value to hobbyists, skin divers, students in biology, and even to professional aquarium staff members.

CLAUDE E. DELISLE

Montreal Aquarium,
La Ronde, St-Helen's Island,
Montreal 103, P.Q.

Science and the Crisis in Society

By Frank H. George. John Wiley and Sons Ltd., Toronto and London. 1970. 166 p. $5.50.

The subject of the book is cybernetics, the science of communication and control. It deals particularly with the control of human behaviour and the manufacture of artificial intelligence.

The author's concern is that because we can now develop models of human intelligence and systematically improve them we are building a man-machine complex which will soon have capabilities well beyond man alone. He hopes we will use that complex efficiently rather than letting it use us. The proper use of the complex is the greatest problem we face in terms of the future of education, business politics, emotions and above all moral considerations.

The author considers society to be cybernetic and that it needs continual adjustment to its goal-seeking activity. He forecasts a future in which all information and production will be automated. Man will go forward in individuality with imagination and colour to develop a better society or, he will disappear because he has lost control of the machine which has made him obsolete.

The book is paper covered, well printed and produced and easy to read. Unless many of us read it, think about George's prediction and act, we deserve to become obsolete.

V. E. F. SOLMAN

Canadian Wildlife Service,
Ottawa, Canada K1A 0W1

The Moths of America North of Mexico, Including Greenland. Fascicle 21, Sphingoidea

By Ronald W. Hodges. E. W. Classey, Ltd. and R.B.D. Publications, Inc. North American Distributor: Entomological Reprint Specialists, Los Angeles, California. 158 p. 14 col. plates, 19 figs. $24.00.

The long-awaited appearance of the first fascicle of this new and monumental encyclopedia of the North American Lepidoptera was a big event. The initiator of the entire work, Richard B. Dominick, has to receive honours not only for his persistence in the pursuit of his idea once it had been conceived, but for the excellent, never before reached perfection of the photographic reproduction in natural size of the coloured plates which he, together with Charles R. Edwards, produced. Here we have illustrations which are not only good for identification without remaining doubt, but which are of stimulating aesthetic value.

Dominick also wrote the "Introductory Note", giving a short history of the whole enterprise and

introducing the principal authors as well as explaining the procedures followed. It deserves praise because it is not written in the usual "antiseptic" style of North American scientific publications. The accompanying photographs of all people intimately connected with the work, are welcome.

In addition to the coloured plates, the fascicle has 19 text figures with line-drawings, excellently done by Elaine R. Hodges, concerning anatomical parts of the moths in question, and at the end two pages "Structural Plates" which are indeed very useful.

Since Rothschild and Jordan's (Novit. Zool. 9, Suppl. CXXXV; 1903) monumental revision of the world sphingid fauna it became clear that some changes in the higher systematics of the family were required. They themselves had left the road open for such a future revision. On this continent Forbes (Cornell Univ. Agric. Exp. Sta. Mem. 274; 1948) made an attempt to do so, but his proposition was not convincing nor satisfactory. Carcasson (J. East Africa Natur. Hist. Soc. & Nat. Mus. 26; 1968) proposed a new systematic order for the African members of the family which while intrinsically valid, used some inapplicable names. Hodges' "Supraspecific categories of North American Sphingidae" seems to me to be the "non plus ultra", at least for our present knowledge. The author however does not treat subspecies as separated entities, as did Rothschild and Jordan and Clark (Proc. New England Zool. Club 4, 6, 7, 9, 11, 12, 13, 15; 1917-1936). He brings their names into the synonymy of the species and treats them in their discussion.

In a few cases the author leaves the door wide open for future research. These cases should be mentioned here to attract would-be future researchers: the genera *Ceratomia* and *Protambulyx;* the species *Sphinx gordius* and *Cressonia juglandis.* Perhaps it may be permitted to suggest here that also the status of *Smerinthus cerisyi* and the western *ophthalmicus* be investigated more thoroughly. Breeding of both "subspecies" in our lab. produced quite different larvae. I have been working on the *Sphinx gordius* complex for some years and it seems as if there really are two species.

Cressonia juglandis is not as the name suggests only a *Juglans* or *Carya* feeder, it is also a widespread *Fagus* and *Ostrya* feeder. Beutenmüller (Bull. Amer. Mus. Natur. Hist. 7: 275-320; 1894) has already stated that *Ostrya* is a foodplant of this species. If this were not so, the species would not exist in Nova Scotia (*Fagus* and *Ostrya* only, no *Juglans* and *Carya*) and in the northern part of southern Ontario (around Sudbury where only *Ostrya* is still found). If the author had consulted "Native Trees of Canada" he would have obtained a much clearer concept of *Cressonia juglandis* in Canada and he would not have said that Clark's *manitobae* "is a color form that occurs across the northern United States and southern Canada". *Manitobae* was described from McCreary, Manitoba, a place where even *Ostrya* is absent. In addition to the Manitoba records, there are some from western Ontario (Nipigon and west) where we find the same (Boreal Forest) vegetation as in northern Manitoba. Our laboratory experiments with *juglandis* have shown that the larvae also take alder and hazel as food. This then would probably be the foodplant of *manitobae,* but it could also be anything else, since to my knowledge nobody ever has found a *manitobae* larva in the field.

The genus *Lapara* is the single genus in the entire book where I can not wholly agree with the author. (See J.C.E.R., a Review of the North American Hawk Moth Benus *Lapara* (Lep.: Sphingidae). Life Sci. Contr., R. Ont. Mus., 79, 1972.

The key to genera on p. 13 which I tested as far as possible, works out well except for the genus *Lapara.* We must include the following species as occurring in Canada, or as having a greater range extension in our country than that given by Hodges: *Agrius cingulatus* as a rare straggler, *Ceratomia catalpae* (Windsor 1944, probably extinguished then), *Sphinx eremitus, Sphinx canadensis* in two not connected distributional areas western Ontario's Rainy River and Thunder Bay Districts and all over southern Ontario and up the Ottawa valley to Ottawa, rare, scattered), *Erinnyis obscura* as a rare straggler in old days, *Erinnyis ello* same, *Aellopos titan* same, *Aellopos fadus* same, *Eumorpha achemon* steadily breeding in southern Ontario; *Hemaris gracilis* only known from more northern parts of the province and never double brooded. *Hyles euphorbiae* was introduced into southern Ontario (as correctly given on plate 14) and not into western Canada.

On p. 50 is said that the genus *Paratrea* in its "single species occurs from Veracruz north to Canada". However, no record for this species is known from collections for Canada.

On p. 67 is said: "Those (i.e. *Sphinx gordius*) from central Colorado and Utah (pl. 5, figs. 8 and 9) are known only from the male sex". This

is not so, there are also females of these in CNC and ROM.

On p. 9 it is mentioned that three species are found in Alaska, but in the text I was able to find only two: *Hemaris thysbe* and *Proserpinus flavofasciatus*. There is at least one record (CNC) known for *Sphinx luscitiosa* from Alaska (it also occurs in the N.W.T. of Canada, which should also be included), perhaps this is the third species?

The generic name *Proserpinus* is by all means masculini generis and therefore, according to the rules, meticulously followed throughout the book otherwise, the specific name has to be assimilated.

On p. 26, figs. 3b and 3d the legend should be corrected in: *left* valve and aedoeagus omitted; on p. 105, fig. 14e the legend should be corrected in: *right* valve and aedoeagus omitted.

Our wish for future fascicles: would it not be possible to show the genitalic characters of all species? And especially the ovipositor lobes laterally, which would add a very handy and important character.

J. C. E. RIOTTE

Department of Entomology and Invertebrate Zoology,
Royal Ontario Museum,
Toronto, Canada.

How to Know the Tapeworms

By Gerald D. Schmidt. Wm. C. Brown Company Publishers, Dubuque, Iowa. 1970. xv + 266 p., 391 figures. $3.85. Available in Canada from Burns and MacEachern Ltd., Don Mills, Ont.

This adds another to the list of more than 30 publications in the picture-key nature series put out by this publisher since the early 1940's. It continues the previous high standard of line drawings and format with keys leading to identification of genera which the author considers valid. The subject matter is a little out of the ordinary for the average naturalist, however, in that it deals with animals found within those animals one normally associates with aquatic and terrestrial habitats. The book is intended for both the beginner and professional parasitologist. Unfortunately it is likely that the beginner will experience difficulty in understanding the keys, at least initially. Nevertheless Schmidt must be commended for attempting a very difficult task, and succeeding so well, notwithstanding the following comments.

The book is set out with a short introduction, description of tapeworm anatomy and stages in the life cycles, and techniques for study, followed by the keys. The section on general morphology is oversimplified and does not prepare the reader for some of the complex terminology in the keys. A glossary at the end, which is mentioned in the table of contents but not in the explanatory pages preceding the keys, is helpful but incomplete. If the author had clearly defined the technical terms that he intended to use, and then been consistent in both spelling and use of these terms throughout, it might have been simpler. As it stands now the keys occasionally are not self-explanatory since they reflect a confused terminology. For example, apparently pleurocercus, pleurocercoid and proglotiddes are used interchangeably in text with plerocercus, plerocercoid and proglottids and to the beginner it might not be clear whether these refer to the same or different things. The first couplet in the keys to subclasses (p. 18) includes reference to a "shelled embryo" although in the explanatory text the apparently comparable stage is referred to as an hexacanth, oncosphere, or larva, but not embryo, shelled or otherwise. In the next couplet, which sets out to separate the orders (p. 19), one must decide if internal segmentation is present or absent, yet the diagnoses for the two orders involved has one with the strobila monozoic (previously defined), whereas the other has "External metamerism absent, internal metamerism present." Nowhere in the book is metamerism defined, although the term keeps reappearing, e.g., pp. 21, 24, 42, 43, etc. Presumably this conflict arises from the use of segment and proglottid interchangeably, although Wardle and McLeod (1952) clearly showed that segmentation and proglottisation are not the same. Unless the reader is a parasitologist well versed in these apparently contradictory terms, he will be hard pressed to know which statement of such couplets he should choose.

The book is primarily a guide to adult worms occurring in the gut of vertebrates, so the key to "larval tapeworms" (p. 18) is not necessary to appreciate most of the remainder of the text. This is fortunate, since this key is disconcertingly incomplete, and, as far as this reviewer is concerned, inaccurate. Among other things it completely overlooks proteocephalidean and tetraphyllidean "larvae" whether from invertebrates or vertebrates, and proteocephalids are common in freshwater vertebrates. The definition of a cysticercoid is untenable. Furthermore, neither the keys nor

descriptions adequately differentiate several cyclophyllidian "larvae" commonly encountered in the viscera of rodents, e.g., *Cladotaenia* spp. and *Paruterina* spp, and possibly *Taenia mustelae* and *T. crassiceps.* Since the beginner is most likely to begin his study of parasites with those in fish, frogs and rodents, this could be a drawback. Perhaps such confusion is inevitable, since even those well versed with tapeworms disagree among themselves about the morphology and identity of both juvenile and adult forms.

Once one gets to the various families and genera within the orders, and has concluded that metamerism and segmentation are used interchangeably, then the keys usually work very well. Most specimens can be identified from whole mounts prepared as described, but one can anticipate difficulty with the Proteocephalidae (p. 118), however, unless cross-sections have been cut. Should this be necessary other books on histological technique can be consulted. All in all this book succeeds remarkably well in doing what it sets out to do, and I am happy to have it ready for use on my bookshelf.

REINO S. FREEMAN

Department of Parasitology,
School of Hygiene,
University of Toronto,
Toronto, Ontario

Environmental Change: Focus on Ontario

By D. E. Elrich [Ed.]. Science Research Associates (Canada) Limited, Don Mills, Ont. Printed by Simon and Schuster, Inc., New York. 1970. 173 p. $4.95.

This book is based on the lecture series "Man and the Quality of His Environment" which was presented at the University of Guelph. It includes contributions of 21 authors and tries to cover all recent changes in environment. Its impact on many of them is not great.

Physical resource aspects of land use is one of the better chapters. The authors deliver some real information and make several good points such as how fertilizer phosphorous is rapidly transformed into insoluble forms and is not easily leached down through the soil whereas excess fertilizer nitrogen is easily lost to the groundwater. However, it is misleading to state that because nitrogen supplies in lakes are adequate, that our main concern about nitrogen in water supplies is the danger it constitutes to the haemogloblin of animals and babies. The section on soils as waste-disposal media (i.e. septic systems) was a waste.

The statement that "U.S. farmers can produce food as efficiently, if not more so, than we can . . ." should have prompted a more complete statement on efficiency which would have disclosed that the quantity of energy poured on crops by U.S. farmers exceeds the amount of energy recovered in the harvested crops; i.e. they are inefficient by a wide margin. In fundamental ecological terms, most agricultural crop systems, especially monocultures are highly unstable ecosystems and, as such, can be maintained only if they receive vast subsidies of energy and matter. Compared to stable ecosystems they are very inefficient and in resource terms, they are very costly. This major point should have been discussed in this book.

A chapter is devoted to pesticides in our environment but if readers want cited references or data they must look in two other chapters. However, none of the discussions of pesticides make it clear, for example, that pesticides do cause eggshell thinning, or that DDT is known to co-distill with water and be transported long distances by air, or that the Ontario peregrine population virtually has been exterminated and that all available evidence points to pesticides as the terminal cause. These environmental changes should have been made clear either in the discussion of pesticides or in the chapter on wildlife.

The discussion of wildlife is really concerned only with direct pathological effects of DDT, fluorides, lead, and oil on large vertebrates; its title is misleading. Many changes in wildlife environments, such as wetland drainage, euthrophication, and changing land use patterns could have been discussed in this chapter. It is unfortunate that most contributors followed the pollution theme rather than taking a truly ecological view as the book's title suggests. MacCrimmon's discussion of fisheries in a changing environment avoids the narrowness of the pollution perspective. His historical, ecological and practical perspectives are broad and his coverage comprehensive.

A good chapter on waste management starts by making a basic law of humanity from a fundamental law of physics. Simply, that many human problems derive from the fact that humans cannot consume, they only can use. Somewhere in this introduction to the problems of solid waste

disposal some space should have been given to the simplest solution of all; reduction of flow of materials into the garbage.

A chapter on plant life is heavily agronomic; weeds "are obviously pollutants, because they affect adversely the ability of a particular area to produce a desirable product — the crop." This viewpoint may have caused the inconsistent stress on fundamental ecological relationships. A pond choked with plant growth is considered unfit for any use although it is mentioned elsewhere that green plants do fix CO_2 and liberate oxygen and that man would be doomed without them. Dangers of overcropping are clearly exposed by the example of Mediterranean goat culture but the opportunity to explain the results in terms of the instability of such an ecosystem is missed. The discussion of bronzing damage in white beans by ozone concentrations in southern Ontario is most interesting. It is presented primarily to indicate that while we work toward reduction of ozone, other practical steps can be taken. The suggestion is that new ozone-resistant varieties be selected for. This is, in fact, what is being done but is this not just one more subsidy (energy, matter and intellect) to be paid into our agricultural system? And why are we forced to pay it? Is it not because agricultural merchandisers have trained their patrons to reject bronzed beans, scabby apples and many other products? The summary of this chapter on plant life is good: ". . . nor have farmers been told that *any* method of short-term, increased food production is acceptable . . . we must never put ourselves in the position of by-passing processes of scientific evaluation of the alternatives, because of either political or economic pressures."

Socio-economic aspects are discussed in four chapters. Some of the discussion is very trivial and much of it very conservative in that it assumes a continuing growth economy. The questions of population growth and urbanization receive belated and brief discussion which seems to strive mainly for scholarly neutrality. A transcript of a mock court hearing on industry's monetary responsibility in pollution abatement is dull reading.

In the last chapter Norman Pearson summarizes several really fundamental socio-economic points. Pearson, at last, points out that the complex which we call pollution is a function of population increase. He also alludes briefly to the idea that humans, too, can fill their environments. He could have put more behind this point because men are loathe to accept the concept of carrying capacity for their own populations. Pearson argues imperatively for inventory of total environment because we cannot otherwise measure how the social progress which is meant to improve our standard of living is actually affecting the quality of our life. Pearson cites environmental sacrifices in regional development of the Maritimes. He makes the beautifully fundamental point that we must stop creating unmanageable problems such as in garbage disposal where we devise packaging to be thrown away with the refuse and then burn it to make the problem widespread. Finally, Pearson says "A code of ecological crimes could be made part of the laws, and environmental courts could deal with the infractions." — a thoughtful idea which might alleviate the downgrading of environmental litigation by judicial value systems based on whip-lashes and broken romances.

H. G. MERRIAM

Biology Department,
Carleton University,
Ottawa, Canada K1S 5B6

Biology and the Social Crisis: A Social Biology for Everyman

By J. K. Brierley. Heinemann Educational Books Ltd., London, 1967. 251 p. $3.00 paper. $7.00 cloth. Available in Canada from Bellhaven House, Scarborough, Ontario.

The book covers a very broad range of topics from heredity, race and health to age, behaviour and population problems.

In the prologue the author says "The most urgent problem is that of population, for unchecked fertility is at the root of most of the social, economic, and health problems the world is facing. Over-population has caused the growth of huge cities with their traffic congestion, special health hazards and all the tensions of urban life; it has caused war and political instability throughout man's history; it has been responsible for the deaths of thousands of babies and infants through hunger and malnutrition; since the dawn of civilization it has caused spoilation of soil followed inevitably by destruction of society".

Having explained the inequality of man by a review of heredity and genetics, the author goes on to discuss gene mutation, natural selection and a consideration of race and colour, and the blood groups and disease resistance associated with racial groups.

From disease, including mental, it is a logical step to food and nutrition and from there to populations and numbers. Population considerations lead logically to discussion of possible methods of population control. Without it habitat destruction will increase as will city life and its attendant problems including crime.

Following a short section on old age and its special and presently growing problems, the author moves to the physics and chemistry of the brain. Here he relates infant scribblings to a number of recently documented inherent brain patterns. He says "One important hypothesis suggests that the brain contains a model of the outside world. We are so familiar with this model that we think it is the outside world, but what we are really aware of is an imitation world, a tool which we can manipulate in the way that will suit us best and so find out how to manipulate the real world which it is supposed to represent. The model or picture, call it what you will, is a highly personal one, because it is made up of data which are *selected.* That is, in our daily lives, indeed from childhood, we all tend to ignore some things and emphasize others. If the model is constructed from data supplied mainly through the eyes, ears and sense of touch (and it must be) then it is clear that faulty sense organs will produce a model that inadequately represents the environment . . . When people have been blind from birth and their blindness is cured they see nothing but confused images which they are not able to identify; these people very gradually learn by trial and error to make a practical model. The practical usefulness of the model is that it agrees very closely with the outside world. When we cross the road and avoid traffic we are really dodging the moving buses and cars in the mind. If the model is inadequate or is used for wishful thinking we should soon be in trouble".

The book is well produced, the tables and diagrams clear and useful. Anyone who wants to understand man's background and potential in relation to the present world situation will enjoy it.

V. E. F. Solman

Canadian Wildlife Service,
Ottawa, Canada K1A 0W1

Ecological Studies. 2. Integrated Experimental Ecology

Methods and results of ecosystem research in the German Solling project. By Heinz Ellenberg [Ed.]. Springer-Verlag, New York. 1971. 214 p. $16.00.

This is the second volume in a series devoted to a synthesis of knowledge on approaches to analysing and modelling the functioning of ecological systems. Volume 1 summarized existing data on temperate forest ecosystems. Volume 2 is an account of methods and preliminary results of the Solling project undertaken by the German Research Association. This project was begun in 1967 with the object of gathering quantitative data about the functioning of forest and grassland ecosystems in the Solling, one of Germany's largest deciduous forest areas, located 55 km northwest of Göttingen. Fifty scientists from various disciplines and institutes are co-operating in this project which is still continuing. Final results are to be presented in a subsequent volume.

This volume is divided into four parts. Part 1 deals with primary production — the conversion of solar energy into living matter by green plants — and is concerned almost entirely with beech trees. Some methods are difficult to apply because of incompleteness. For example, a formula is given for calculating the standing crop biomass of beech:

$$y = -0.3518326 + 0.9356902x$$

where $x = \log \frac{1}{4} d^2 . \pi . h$,
d = diameter at breast height,
h = height of tree,
y = log total dry weight in kg.

Whether seven significant figures are justified is questionable. Nevertheless, this is a potentially very valuable formula but the units of diameter and height are not specifically given although, from what is written previously, one assumes they are in meters. Unfortunately, the reader is referred to a separate paper (no reference given) for a discussion of problems about applicability and range of validity of the formula.

Methods are also described for measuring carbon dioxide exchange, transpiration, and leaf area which are interesting and informative.

Part 2 is devoted to secondary productivity, the food and energy turnover of arthropods and micro-organisms. Methods are presented for surveying species density as well as activity and for determining population dynamics, standing crop,

and production of whole populations including soil bacteria. In a section on population dynamics of predatory arthropods of the soil surface, a formula is presented which purports to calculate the total number of individuals that entered any particular stage in the case where the egg-laying period extends over a period longer than the duration of the stage. The formula is

$$N = \frac{T}{t} \cdot \bar{n} \text{ where}$$

N = total number of individuals reaching a given stage,

$\bar{n}$ = mean catch per sample date,

T = duration (days) of the period during which individuals of the stage in question have been captured,

t = duration of stage under natural conditions.

Assuming that what is meant by T is the length of the trapping period, then if T is longer than t, the formula seems to me to be reasonable. For example, if the trapping period is 28 days and the duration of the stage is 7 days, then $n \times 4$ should give a reasonable estimate of the total number of individuals which entered the stage. But I fail to see the general applicability of the formula in other cases.

Part 3 is an assessment of environmental conditions in the areas studied including climatic conditions and the chemistry and micromorphology of soils.

Part 4 is listed as concerning the general applicability of the results but consists of only two short reports which are inconclusive.

The chapter headings, generally, are slightly overambitious and, reading them, one gets the impression that there must be more empirical facts presented than there actually are. But the methods presented are interesting and although many of them are not new, the great value of the book is that these methods are brought together in a single volume. Anyone engaged in a quantitative study of natural populations of plants or animals should have this book in his library.

C. A. BARLOW

Department of Biology,
Carleton University,
Ottawa, Canada K1S 5B6

Air Pollution

By C. W. Lavaroni, and P. A. O'Donnell.

Water Pollution

By C. W. Lavaroni, P. A. O'Donnell, and L. A. Lindberg.

Noise Pollution

By P. A. O'Donnell, and C. W. Lavaroni.
Addison-Wesley Pub. Co., Menlo Park, Calif. and Don Mills, Ontario, Canada. 1971. 94 p. $1.85.

The young people of today are more aware of their environment than any previous generation. The mere mention of the word, "pollution" sparks an instant reaction — anger, disgust and an eagerness to 'clean-up'. They will be able to specify local examples — garbage piled behind neighbouring stores, industries that are pumping out clouds of black smoke and machines that are offending their ears. Teachers, however, were faced with a problem. *They* were enthusiastic, the students were eager and had cleared the schoolyard of any debris, clipped all the articles on the subject, collected newspapers for recycling, etc. but how did the teacher undertake the task of explaining the more complicated chemical and technical aspects of environmental damage by pollution? A trio of new books offers a valuable solution to the problem.

Patrick A. O'Donnell, *et al.* have presented teachers and students with an activity series of three books entitled respectively, 'Water Pollution', 'Air Pollution', and 'Noise Pollution'. Individual Teachers' Manuals and Student Texts are available in each title. Although the books are on different topics, they each follow the same format.

With these particular books, a teacher need not hesitate to spend an entire month or two covering pollution for fear of neglecting all the other subjects. O'Donnell, *et al.* have made the three completely cross-disciplinary and interdisciplinary. For example, in Chapter Two of 'Water Pollution' — 'Water, a Vital Resource', in only two pages, they offer the following suggestions:

Health — 'Have a physician visit your class to discuss how the human body absorbs, stores and eliminates water . . .'

Geography — 'Locate mapor industrial complexes on a map . . . Why do industries require an abundance of water?

English — 'The topic, 'The Year We Began to Run Out of Water', would provide an excellent creative writing experience.'

Math — 'How much water would they need to have sufficient for essential uses? (daily use in the home)

The suggestions are both practical and stimulating, avoiding the idealistic tendency of some Teachers' Manuals. In the majority of cases, equipment is readily available.

From the student's point of view, these books are enjoyable, pleasant and easy to use. Each book begins by presenting the 'Problem'. Actual photos of the results of pollution and startling accounts of the damage, arrest the student's attention immediately and enable him to parallel his own experiences with those illustrated. (Were *you* aware that in 1930 in the Meuse Valley in Belgium, 63 people died of air pollution or that due to the water pollution, the Cuyahoga River in Cleveland, Ohio burst into flames in 1969?). This chapter enables the child to look around his own environment and assess its condition. He may be interested in oil pollution on the ocean coast or in the Arctic, but the explanation of why he is unable to swim at the local beach, is much more meaningful. The defining of the problem for themselves makes them aware of the smaller, less obvious warning signs and evidences of pollution. Thought-provoking questions at the end of the chapter test the students' abilities to observe, assess and draw logical conclusions.

Once the pupils have clarified the problem(s) in their own mind and mastered the simple observation and recording skills, the authors encourage the liberal use of the books by the student in any particular order that appeals to him. Of course, the entire class may approach it as a unit, and many concrete suggestions are offered for the teacher taking that approach.

Imaginative, and in many cases, humourous illustrations reinforce the information, facts, history, statistics, etc. of Chapters 2. These chapters help the student clarify the role of the resource being destroyed and the physical properties of each. Ideas like that of noise being relative are introduced. Perhaps some of these students will be more understanding of their parent's complaints.

The most exciting aspects of the book — the activities and experiments, are explained in Chapter Three. Here they have the opportunity to explore pollution for themselves. (There are still many suggestions for the teacher to make the most effective use of all the experiments). Twenty to twenty-five progressive experiments and activities enable the student to build on his accumulation of pollutant facts. The activities are directed enough that the student has guidance to work alone and discover a particular aspect, and yet provide room enough to let imagination play an important role. Here, he gathers statistics, records data, mixes chemicals and tests sound equipment for quality. The materials required for these can be found not only around the classroom but also in the home, which allows the child to progress and pursue his interests even over the weekends and evenings. Thus, the more complicated chemical aspects of pollution are broken down into easily comprehended experiments that give students the basic understanding that will be necessary as they move on to high school.

The final chapter in each of the books, 'Extending Your Ideas' very tidily sums up what I feel Mr. O'Donnell and associates had intended their books to be — doorways to more detailed and extensive research into each of these areas. The authors have provided them with the basic understanding in the previous chapters, now they offer them leads into new fields. Each section of questions begins with one or two that have the answer contained within the book, the others build upon the answers to these and require that the student calculate the answer for himself. The questions cover such a range and scope that there should be no difficulty in locating questions for those interested in art, geography, chemistry, etc.

The books are particularly suited to the Junior levels of the elementary system, but challenging enough to make worthwhile activities for the intermediate grades, and in places, simple enough for the teacher to introduce the topic to the primary grades. An added incentive to those students who believe that adults should practise what they preach, is that all the books are printed on recycled paper.

Although teachers should all welcome the advent of Mr. O'Donnell's books on the educational scene, perhaps the most necessary one is 'Noise Pollution'. We can all hear noise pollution, and know that it is irritating and damaging, but how can you explain what it does and how to differentiate? The authors have done an excellent job of accomplishing this.

Teachers will appreciate the fact that not only are the disciplines covered in these exciting texts, but value judgments, distinguishing between observations and assumptions, drawing conclusions, recording data, and other abstract ideas are stressed.

Miss J. Rawes

Resource Teacher
MacSkimming Natural Science School,
Cumberland, Ontario.

Introduction to Fungi

By John Webster. Cambridge University Press, London and New York. 1970. 424 p. $9.75. Available in Canada from the Macmillan Co. of Canada, Toronto.

This book is suitable for an introductory University level course on the morphology and taxonomy of the fungi. It is designed to make use of readily available material for class purposes. Although the book originates in Britain the material with few exceptions is just as readily available in Canada.

Webster has followed the "General Purpose Classification" proposed by Ainsworth. In introductory level courses, the taxonomic system followed is not critical and any reasonable system is acceptable. For the most part the classification followed is satisfactory but I have to disagree with placing the Erysiphales in the Plectomycetes and *Ceratocystis* in the Eurotiales. It is a little confusing when the author describes the ascocarps in the Plectomycetes as rudimentary or globose cleistocarps and subsequently includes perithecial forms.

It is a pleasure to read such a nicely illustrated text. The line drawings are mostly original and of the highest quality. There is a nice balance between photographs and line drawings selected for illustrative purposes. Despite the fact that the book is printed by offset techniques, the photographic reproductions fared very well. The author is to be commended on his generous use of illustrations to support the written material.

There are two notable omissions of groups that I would personally like to see in any introductory course in fungi. Firstly, the slime moulds are given scant attention. It might be argued that they are not true fungi and that there is more than enough to cover without them. They are, nevertheless, a beautiful and interesting group well worth attention and have traditionally been studied by mycologists. The second major omission is the Deuteromycetes. The conidial states are to be sure well covered in association with their perfect states, but I would prefer a more formal taxonomic approach to this group.

The book is well written and error free. It is nicely organized, very well illustrated and a very useful addition to the narrow spectrum of books available in this area.

G. L. BARRON

Department of Botany,
University of Guelph,
Guelph, Ontario.

The Biology of Higher Cryptogams

By William T. Doyle. Macmillan Co., New York. 1970. 163 p. illus. $6.10. Available in Canada from Collier-Macmillan Canada Ltd., Toronto.

The author has attempted in five short chapters and 163 pages to discuss the higher cryptogams (mosses to ferns) from the standpoint of their geological record, life cycles, morphology, anatomy, diversity, relationships and finally to quote the publisher's note, "the exciting recent experimental work" on spore germination, morphogenesis, sex-determination etc. It is a "tall order" and largely unsuccessful. Although the reader is told in the preface that he will need only an elementary knowledge of Biology, he is soon exposed to many morphological terms such as calyptra, operculum, apophysis, peristome as well as carinal canals, telomes, exarch, endarch and mesarch patterns of protoxylem. Each of these terms has to be described or defined in the text as there is no glossary. The reader is also told that there are three forms of malic acid and is launched into *cis* and *trans* forms of maleic and fumaric acids.

The style of the author is pedantic — "The purpose of this chapter is . . .", "A brief account of . . . will close this chapter". To me, it is a dull book. All too reminiscent of a dull second or third year classical Botany course, e.g. "The protenema of many mosses has two distinct growth phases called the chloronema and the caulonema" — please memorize and repeat back.

What of the "exciting recent work"? Here the author reverts to the file card approach — "The half-life of bud formation is on the order of five hours (Bopp and Diekmann, 1967)". The author tends to be cryptic and the review will only be intelligible to the reader who is already familiar with the field, e.g. hormonal control of growth, with line upon line of tRNA, mRNA and sRNA. In this chapter, the author is quite cautious in his interpretations of recent work, relying heavily on statements of fact backed by literature citations. There is little exposition on the significance or ultimate objectives of some of the modern experimental studies.

This book contains much valuable information and is well illustrated, but it is over-priced at $6.10. A general reader, or even a student of Botany will not find it light and stimulating reading.

DONALD M. BRITTON

Department of Botany,
University of Guelph,
Guelph, Ontario.

Papers on Evolution

Selected by P. R. Ehrlich, R. W. Holm and P. H. Raven. Little, Brown and Company, Boston. 1969. 564 p. $8.00. Available in Canada from McClelland and Stewart, Toronto.

In 1970 the California State Board of Education passed a ruling that the new science framework must include the scientific theory of creation. Such a move has appalled evolutionists both within and without the state of California. To read the collection of papers under review, written between 1941 and 1966, however, will dispell any doubt of *the change which occurs in organisms in the course of time* — evolution.

In any selection of papers from the literature to adequately cover a subject in a concise fashion, one is presented with a formidable task. But from a field where "one might reasonably claim that all biological research deals with evolution" this presents a special challenge. As a result the editors have categorized papers in five sections, namely, I. Changes in Populations, II. The Origin of Species, III. Reticulate Evolution, IV. Major features of Evolution and V. The Evolution of Man. Each section commences with an introduction to the topic and contains from five (Section III) to 14 papers (Section IV). In the introduction to each section references are given to other aspects of the subject for supplementary reading.

The whole collection of papers has been assembled not as a text book but as supplementary reading to a text. From this point of view, a student may have at first hand an in-depth treatment of subjects which can only be covered in summary fashion in a text.

In looking at the journals from which the papers were derived one may question the lack of selections from European journals. With the exception of one paper from the New Scientist (London, England), the 37 remaining selections are from journals published in the United States. Of these, 13 are from Evolution, five from Science and four from the American Naturalist. On the other hand, the convenience of this collection of papers in a single volume will be found most useful for ready reference to examples of evolution in plants, animals, and man.

WILLIAM F. GRANT

Genetics Laboratory,
Macdonald Campus of McGill University,
Ste. Anne de Bellevue 800, Quebec

Man and His Environment: Climate

By David M. Gates. Harper and Row, New York. 1972. 175 p. $3.25 paper, $5.95 cloth.

This book is one of a series of texts edited by John Bardach, Marston Bates and Stanley Cain all of whom are well qualified in the environment field. Other titles include: Waste, Law and Food and in preparation Energy, Recreation, Population and Policy and Administration. If the others do their job as well as Climate, they will provide a wealth of information on environmental problems for general readers in non-technical language.

The book's first sentence says, "Despite the fabulous advances in modern technology, man's well-being and sustenance is still utterly and completely at the mercy of climate". The six chapter headings include 1. the weather, 2. climate factors, 3. climate classification, 4. climate and man, 5. animals and plants, 6. climate change and pollution.

Chapter 1 is a capsule course in meteorology from the general circulation of the atmosphere through interaction of air masses to the frontal storms that characterize temperate zone weather.

Chapter 2 deals with radiation to and from the earth, temperature distribution, slope and exposure effects on vegetation, wind, including such excesses as tornadoes, precipitation and some relationships of large bodies of water to precipitation downwind from them.

Chapter 3 compares three main climatic classifications and reviews microclimatic effects particularly in relation to exposure and clothing.

Chapter 4 takes us all the way from a sauna at 120°C (260°F) through tropical deserts at 158°F to the −127°F of Antarctica and shows how man can tolerate them all. The example of a resting adult generating heat equal to that of a 75 watt bulb while a 5 year old equals that of a 120 watt bulb is simple and instructive.

Chapter 5 does for animals and plants what chapter 4 does for man. It explains why a slender Arabian horse is adapted to a hot climate while a shetland pony's stocky body, short legs and long thick hair suit it to a cold, wet windy region. It also explains why native prairie vegetation was not killed off like the introduced cereal grains in the "dust bowl" days of drought on the prairies.

Chapter 6 reviews some of the classic pollution disasters of the past including Donora Pa. in 1940 and London in 1952, the latter with 2,700 excess

deaths in the week in which the pollution occurred.

The book is well produced, illustrated with simple diagrams and useful tables and is very easy to read.

V. E. F. SOLMAN

Canadian Wildlife Service,
Ottawa, Canada K1A 0W1

Engineering Aspects of Thermal Pollution

By F. L. Parker, and P. A. Krenkel (Eds.). Vanderbuilt University Press, Nashville, Tenn. 37203. 1969. 351 p. $7.95.

The proceedings of the National Symposium on Thermal Pollution sponsored by the Federal Water Pollution Control Administration of the United States and Vanderbuilt University was held in Nashville, Tennessee, August 14-16, 1968. This symposium was preceded by one on implications for aquatic life of thermal pollution which is recorded in another volume "Biological Aspects of Thermal Pollution".

The book consists of 351 pages of non-glossy paper and the print is not too small. The material in the book is clearly presented with table of contents, list of illustrations, list of authors and participants, twelve chapters with adequate titles and subtitles, and finally an index. The format of the book makes for easy reading. Each chapter is followed by a discussion from invited speakers and finally by a general discussion from the floor. It is refreshing to note that the discussions usually pertained to the same topic presented by the main speaker.

The authors and participants were mostly from the United States, with one from France and two from the United Kingdom. There were no participants from Canada. Although some of the points raised in this symposium have general validity, great caution must be exercised in extrapolating information applicable in the United States to the Canadian scene where the lakes and rivers are larger and the seasonal temperatures lower.

The addition of heat to natural waters may affect chemical, physical and biological processes. If the observer is neutral, this addition of heat may be said to have *thermal effects*. If the addition of this heat to the waters is judged to be bad, the situation is described as *thermal pollution;* on the other hand, if it is considered to be beneficial it may be described as *thermal enrichment*. From the title of the book it may be seen that only one aspect, pollution, has been selected for detailed discussion. In the preface of the book it is acknowledged that there is yet little damage from thermal pollution but a great interest in the problem.

The first three chapters, about a third of the book, have little to do with engineering aspects. The first chapter, a keynote address, is an attempt to place waste heat in perspective. The author dwells on the biological aspects, mainly of a detrimental kind, of adding heat to waters. Prevention of thermal degradation and technological control of heat discharges are also stressed. The second chapter describes ecological changes as a result of discharges of heated waters. Because the author uses mainly polysyllabic terms or the scientific jargon of his trade it is difficult to understand the contents of this chapter. He raises the question of whether biological indicators are useful as markers for adverse effects of heat. It was concluded that the best way to monitor was by physical means rather than by attempting to detect changes in biota. However, other broad ranging indirect effects on the local ecology might need to be studied.

It is generally thought that the toxicity of chemical pollutants increases with increasing temperature. This observation is important because thermal pollution is usually associated with other pollution. Nevertheless, this raises a problem of data interpretation and it is often difficult to pinpoint temperature, nutrient, or other factors as causative agents for observed harmful effects.

The third chapter on water quality standards for temperature stresses difficulties of applying and administering such standards. It also brings out problem of defining mixing zones according to location, size, character and use.

Often these is a tendency to set standards very conservatively. This might be popular with the public, but they may not be aware to what extent power rates will have to be increased to bring about this extra cooling.

Although the literature is replete with papers detailing relationships between temperature and aquatic life, one member of a regulatory agency stated publicly that he lacked confidence in the criteria dealing with temperature.

The remainder of the book deals more directly with engineering aspects.

Detailed descriptions of different types of sites for cooling of riverside thermal power plants, and temperature measurements downstream from these sites, indicated that is was difficult to generalize and to predict heat dissipation based on present day theories. Mechanisms of heat loss and mathematical formulations were discussed briefly.

In considering whether all or a portion of total waste-heat is to be disposed of into an adjacent waterway, it was suggested that use should be made of the best theoretical and experimental techniques in the planning and design stages. Two extremes of heat dissipation were described from the theoretical viewpoint, complete mixing and stratification, but it was acknowledged that quantitative information between these two extremes was lacking. It was concluded that by proper design heat dissipation ranging between the two extremes could be achieved in practice. In general dissipation of heat by complete mixing was most appropriate into large bodies of water, oceans or large lakes, while stratification over small streams was more effective in rapid transfer of heat to the atmosphere. It was pointed out that a maximum temperature rise (Δt) or a fixed temperature in a stream to control thermal pollution could not be specified for each site without appropriate operational studies being carried out to find impacts on local ecology.

The modelling of heated water discharges as practiced in the United Kingdom was of great interest to the symposium participants because it has not been carried out extensively in the United States. General principles of hydraulic laws were outlined and detailed comparisons of models and prototype observations in several situations were given. Six stages of heat dispersion were described in detail including mathematical formulations. Based on quantitative information it is possible to go to physical modelling, for example, to test for recirculation. It was pointed out that humidity and wind are important factors to be considered as well. The geographical location of the model (usually in a laboratory) may invalidate the direct applicability of results from the model to the prototype in the field.

The design and operation of cooling towers were discussed. However, the discussion was restricted to design criteria that experience had shown to be practical rather than those based on theoretical aspects of tower structure and evaporation theories. The performance of cooling towers was influenced greatly by changing weather conditions. In spite of this, cooling towers have been constructed without undue incorporation of large safety factors.

Costs of once-through-cooling and recirculation cooling, and costs to the downstream user were compared. These comparisons indicate that economic considerations should have little influence in setting temperature standards. Local ecological changes and other uses of the stream appear to have more significance in establishing waste heat limits. The cost of installation of recirculation cooling to a power plant would be a small percentage of the cost of generating and distributing electricity.

It was observed that run-of-river and bay or lake systems for accepting power plant thermal discharges have a very limited future because of government restrictions. Perhaps in the United States these water systems are close to being saturated, but such a limitation in Canada cannot apply at the present time.

It was pointed out that although the capital and operating costs of cooling towers and lagoons were not prohibitive, these costs were still large enough so that they could not be ignored.

It was noted that cooling towers might have adverse effects from the public relations viewpoint. They can affect local meteorological conditions adversely and cause fogging and their large size is said to degrade the esthetics of the landscape.

The summary and status of the art and research needs for thermal pollution control, are the last two topics discussed at the symposium. Unless there is a breakthrough in new technology, which appears remote at the present time, it seems that because of increasing electricity production there will be a corresponding increasing burden of waste heat injected into the environment. Society must be prepared to pay the costs of preventing discharges of waste heat into water systems or else accept the consequences of discharges of thermal effluents.

The review of the biological effects of discharges of waste heat remains the most controversial and emotional problem. It was stated: "The major portion of the first National Symposium on Thermal Pollution concerned itself with the biological effects. From an engineer's point of view, it was quite disheartening because of the lack of solid information upon which to base criteria, standards and design." Reference was made to biologists in the United Kingdom, who after nine years of research on the biological effects of heat

effluents discharged into streams, downstream from nuclear power plants, concluded from their study that thermal pollution was a misnomer.

Although biological effects are incompletely known, some specific effects on important fish have been observed. For this reason, if releases of waste heat to the environment continue to grow it is most important to set at least in some instances upper limits to discharges of heat into the water systems. Also a plea is made for further studies into the utilization of waste heat for aquaculture, irrigation and keeping navigable waters open during the winter.

In conclusion, it may be said that the book is well worth reading.

A. M. MARKO

Biology and Health Physics Division,
Chalk River Nuclear Laboratories,
Atomic Energy of Canada Limited,
Chalk River, Ontario.

OTHER NEW TITLES

*__Arctic Adaptations in Plants.__ D. B. O. Savile. Plant Research Institute Monograph No. 6. Canada Department of Agriculture, Ottawa. 1972. 81 p.

Arctic Bibliography. Maret Martna. McGill-Queen's University Press, Montreal. 1972. Vol. 15. 1600 p. $30.00. This book provides a key to scientific publications available in the principle libraries throughout the world, relating to Arctic and Subarctic and other low-temperature conditions. Vol. 5 assembles abstracts of recent scientific publications and makes this large compilation available to all who are concerned with northern research and development.

Bibliography of Climatology for the Prairie Provinces. R. W. Longley and J. M. Powell. University of Alberta Press, Edmonton. 1971. 64 p. $5.00.

Bird Watcher's Year in New Brunswick. D. Hermode Parr. Brunswick Press, Fredericton, N.B. 1972. $4.50. The author's personal experiences watching birds in New Brunswick. These are listed by months so that the reader will know what to look for throughout the year.

The Birds of Zambia. C. W. Benson, R. K. Brooke, R. J. Dowsett, and M. P. S. Irwin. William Collins Sons Co., London. 1971. 414 p. £2.50.

British Prosobranchs. Alastair Graham. Academic Press Inc., New York. 1971. 112 p. $4.00.

*__A Citizen's Guide to Air Pollution.__ David Bates. Environmental Damage and Control in Canada. Vol. 2. McGill-Queen's University Press, Montreal. 1972. 250 p. $2.95 paper, $5.00 cloth.

Chromosome Atlas: Fish, Amphibians, Reptiles and Birds. Vol. 1. K. Benirschke and T. C. Hsu [Eds.]. Springer-Verlag, New York. 1971. Unbound folios. $14.80.

Common Weeds of the United States. U.S. Dept. Agriculture. Dover Publications, New York. 1971. $4.50.

*__Computer Mapping as an Aid in Air Pollution Studies.__ Jean-Maurice Granger. Sarracenia 15: 42-83. Centre de Récherches Ecologiques, Université de Montréal, Montréal.

Conservation for Survival: An Ecological Strategy. Kai Curry-Lindahl. Wm. Morrow Co., New York. 1972. 335 p. $6.95. A survey of ecological problems on a global scale, and presents the case for application of conservation principles.

Detergents in Water: A Bibliography. U.S. Department of Interior Water Resources Scientific Information Center, Washington, D.C. 1971. 460 p. $3.00 paper, $.95 microfiche. Available from National Technical Information Service, Springfield, Va.

Diving in Marine Mammals. R. J. Harrison and G. L. Kooyman. Oxford University Press, London. 1971. 16 p. 20 pence. Oxford Biology Readers No. 6.

The Eastern Panther. Bruce S. Wright. Clarke Irwin Co., Toronto. 1972. 200 p. $6.50. Presents the case for the preservation of the eastern panther, long thought to be extinct and still rare. He tells when the panther has been seen and describes the process by which its presence has been verified and its habits studied.

The Ecology of Devastation: Indochina. J. Lewallen. Penguin Books Inc., Baltimore. 1971. $1.65.

Ecosystem Structure and Function. J. A. Wiens [Ed.]. Oregon State University Press, Corvallis. 1972. 176 p. $5.00.

*__Effet de l'Industrialisation et de l'urbanisation sur la Vegetation Epiphyte de Montréal.__ F. LeBlanc, and Jacques De Sloover. Sarracenia 15: 1-41. 1972. Centre de Recherches Ecologiques de Montréal, Université de Montréal, Montréal.

Environment and Archaeology: An Ecological Approach to Prehistory. Karl W. Butzer. Aldine-Atherton Co., Chicago. 2nd ed. 1971. 704 p. $15.00.

*__Environmental Kit for Elementary School Teachers in the Ottawa Valley.__ Pollution Probe Ottawa. 1972. 56 p. + appendices. $1.25. Available from Pollution Probe Ottawa, Carleton University.

Examples in Quantitative Zoology. G. M. Jarman. Edward Arnold Co., London. 1971. £1.10.

A Field Guide to the Birds of Mexico and Central America. L. Irby Davis. University of Texas Press, Austin, Texas. 1972. 282 p. $6.50 paper, $10.00 cloth. John Fielding and Lois Lasater Maher Series No. 1.

A Field Guide to the Birds of the West Indies. J. Bond Houghton Mifflin Co., Boston. 2nd ed. 1971. 256 p. $8.95.

Field Work of a Museum Naturalist. Alfred M. Bailey. Denver Museum of Natural History, Denver, Colo. 1971. 192 p. $2.50. Museum Pictorial No. 22.

*The Fisherman's Handbook.** J. Power and J. Brown. Charles Scribner's Sons, New York. 1972. 192 p. $6.95. Available in Canada from Burns and MacEachern Ltd., Don Mills, Ont.

Flora Neotropica. Monograph No. 6, Tremellales. Bernard Lowy. Hafner Pub. Co., New York. 1971. 153 p. $12.95.

Fossils: A Study in Evolution. J. O. I. Spoczynska. Rowan and Littlefield Co., Totowa, N.J. 1972. 208 p. $8.00.

Fundamentals of the Fungi. Elizabeth Morre-Landecker. Prentice-Hall Inc., Englewood Cliffs, N.J. 1972. 482 p. $16.00.

The Great White Bears. R. W. Nero. Dept. Mines, Resources and Environmental Management, Winnipeg, Man. 1971. 16 p.

The Hazardousness of a Place: A Regional Ecology of Damaging Events. Kenneth Hewitt and Ian Burton. University of Toronto Press, Toronto, Ont., and Buffalo, N.Y. 1971. 154 p. $5.00. University of Toronto, Dept. Geography Research Publications No. 6.

The Invertebrate Panorama. J. E. Smith, G. Chapman, R. B. Clark, D. Nichols and J. D. Carthy. Weidenfeld Nicolson, London. 1971. £2.00.

Introduction to the Fishery Sciences. William F. Royce. Academic Press Inc., New York. 1972. 352 p. $14.50.

Invitation to Biology. Helena Curtis. Worth Publishers, New York. 1972. 587 p. $9.75. A first year biology text, profusely illustrated in black and white and colour.

Just a Bunch of Trees. H. A. Cunningham. Dept. Mines, Resources and Environmental Management, Winnipeg, Man. 1970. 31 p. free.

*Kamloops: An Angler's Study of the Kamloops Trout.** Steve Raymond. Winchester Press, New York. 1971. 209 p. $14.50.

Life in a Log. G. I. Schwartz and B. S. Schwartz. Natural History Press, Garden City, N.J. 1972. 138 p. $5.95. Takes the reader into the little known world of life in a decaying and finally "dead" tree and tells the reader about the plants and animals that live on and contribute to the decomposition of the log.

Life in Mud and Sand. S. K. Eltringham. The English Universities Press Ltd., London. 1971. 218 p. £1.59 paper.

The Limits to Growth. D. H. Meadows, D. L. Meadow, J. Randers and W. H. Behrens. Potomac Assoc.-Universe Books. 1972. 205 p. $2.75 paper, $6.50 cloth. A report for the Club of Rome's Project on the Predicament of Mankind.

*Man and His Environment. Vol. 1.** A. M. Ward [Ed.]. Proceedings of the First Banff Conference on Pollution. Pergamon Press, New York. 1971. 196 p. $12.00.

Mato Grosso: The Last Virgin Land. Anthony Smith. Michael Joseph Co., London. 1971. 288 p. An account based on the Royal Society and Royal Geological Society expedition to Central Brazil.

Man's Impact on Terrestrial and Oceanic Ecosystems. W. H. Mathews, F. E. Smith, and E. D. Goldberg. MIT Press, Cambridge, Mass. 1972. 540 p. $19.50.

Megistos: A World Income and Trade Model for 1975. C. Dupre and E. S. Kirschen [Eds.]. Elsevier Pub. Co., New York. 1970. 668 p. $35.00.

Metallic Contaminants and Human Health. D. H. K. Lee [Ed.]. Academic Press Inc., New York. 1972. 242 p. $7.00. Environmental Sciences. Fogarty International Center Proceedings No. 9.

Methods for the Estimation of Production of Aquatic Animals. G. G. Winberg [Ed.]. Academic Press, London and New York. 1971. 175 p. $9.00.

Methods for the Study of Marine Benthos. N. A. Holmes and A. D. McIntyre [Eds.]. IBP Handbook No. 16. Blackwell Scientific Publications, Oxford and Edinburgh. 1971. 334 p. $13.50 .

Methods of Study in Soil Ecology. J. Phillipson [Ed.]. Proc. Paris Symposium organized by UNESCO and IBP. Title II of the Ecology and Conservation Series. UNIPUB Inc., New York. 1970. 303 p. $17.00.

Microbes and Biological Productivity. D. E. Hughes and A. H. Rose [Eds.]. 21st Symposium of the Society for General Microbiology, University College, London. Cambridge University Press. 378 p. $16.00.

Mid-Continent Lepidoptera Series. John H. Masters [Ed.]. A number of publications on the Lepidoptera of North America, with particular reference to the mid-continent. Of particular interest to Canadians are the following titles: Ecological and Distributional Notes of Butterflies of the Genus *Erebia* in Manitoba; A Preliminary List of Lepidoptera of Manitoba; Butterflies and Skippers of Northern Ontario; A Preliminary List of Butterflies of Saskatchewan; The Butterflies of Churchill, Manitoba. These and others sell for $1.00 each from P.O. Box 7511, Saint Paul, Minn. 55119.

*The Milepost.** Alaska Northwest Publishing Co., Box 4-EEE, Anchorage, Alaska 99509. 466 p. $2.95.

*Mountain Sheep: A Study in Behaviour and Evolution.** V. Geist. University of Chicago Press, Chicago and London. 1971. 383 p. $14.50.

The Moving Continents. Frederic Golden. Charles Scribner's Sons, New York. 1972. 124 p. $6.95. A succinct and clear presentation of the findings about continental drift and the research that established these facts.

A Naturalist in Southern Florida. Charlotte Orr Gantz. University of Miami Press, Coral Gables, Fla. 1971. 256 p. $7.95.

Nautral Resource Policy in Canada: Issues and Perspectives. Thomas L. Burton. McClelland and Stewart Co., Toronto. 1972. 256 p. $4.95. Provides a perspective on the current debate on what to do with our natural resources. It lays forth the alternatives, shows where various people and groups stand on the main issues, and offers the framework for an action plan for natural resource planning in Canada.

Natural Resources of the Soviet Union: Their Use and Renewal. I. P. Gerasimov, D. L. Armand, and

K. M. Yefron. W. H. Freeman Co., San Francisco. 1971. 349 p. $12.50.

Organogenesis of Flowers. Rolf Sattler. University of Toronto Press, Toronto. 1972. 240 p. $20.00. The first photographic text-atlas of botany. It describes the floral development of 50 species of flowering plants. Each chapter is devoted to one species and consists of a floral formula, floral diagram, sequence of primordial inception, description of floral organogenesis, a bibliography and photographs.

Petroleum Conservation in the United States: An Economic Analysis. Stephen L. McDonald. Johns Hopkins Press, Baltimore. 1971. 279 p. $10.00.

Pigeons and Doves of the World. Derek Goodwin. British Museum of Natural History, London. 1970. 2nd ed. 446 p. £7.00.

Polar Deserts. Wally Herbert. Franklin Watts Inc., New York. 1971. 128 p. $4.95.

The Praying Mantis. Insect Cannibal. Lilo Hess. Charles Scribner's Sons, New York. 1971. $4.95. Extraordinary close-up photos, with detailed description of the ways of the mantis, from hatching to death.

Principles of Mammalian Aging. R. R. Kohn. Prentice-Hall Inc., Englewood Cliffs, N.J. Foundations of Developmental Biology Series. £2.00 paper, £4.00 cloth.

The Principles of Pollination Ecology. K. Faegri and L. Van der Pul. Pergammon Press, New York. 1971. 2nd rev. ed. 291 p. $14.00.

Project Aqua: A Source Book of Inland Waters Proposed for Conservation. H. Luther and J. Rzoska. IBP Handbook No. 21. IUCN Occasional Paper No. 2. 1971. Blackwell Scientific Publications, Oxford and Edinburgh. 239 p. £2.00.

Rapid Population Growth: Consequences and Policy Implications. Vol. 1. U.S. National Academy of Sciences. Johns Hopkins Press, Baltimore. 1971. 696 p. $20.00.

Rocky Mountain Flora: A Revised Field Guide Edition. William A. Weber. Colorado Associated University Press, Boulder, Colo. 1972. $7.95.

Science and Politics in Canada. G. B. Doern. McGill-Queen's University Press, Montreal. 1972. $12.50.

***The Snakes of Canada.** Barbara Froom. McClelland and Stewart, Toronto. 1972. 128 p. $6.98.

Soil Micro-organisms. T. R. G. Gray and S. T. Williams. Hafner Pub. Co., New York. 1971. 240 p. $9.95. University Reviews in Botany Series.

Some Aspects of the Releases of Radioactivity and Heat to the Environment from Nuclear Reactors in Canada. P. J. Barry [Ed.]. Atomic Energy of Canada Ltd., Chalk River, Ont. AECL Publ. No. 4156. 82 p.

The Spotted Hyena: A Study of Predation and Social Behaviour. Hans Kruuk. University of Chicago Press, Chicago. 1972. 335 p.

SST Handbook for 1972. W. A. Shurcliff. Citizens League Against the Sonic Boom, Cambridge, Mass. A digest of Boeing SST and Concorde SST items through Dec. 1, 1971 with documented summary of technical and economic arguments.

The Structure and Function of Freshwater Microbial Communities. John Cairns Jr. [Ed.]. Virginia Polytechnic Institute and State University, Blacksburg, Va. Available from Mrs. Norma P. Douglass, Derring Hall, V.P.I.S.U., Blacksburg, Va. 1971. 302 p. $5.00. Research Division Monograph 3.

Synoptic Plates of Higher Marine Fungi: An Identification Guide for the Marine Environment. J. Kohlmeyer and E. Kohlmeyer. 3rd ed. Verlag von J. Cramer, Lehre, Germany. 1971. 87 p. 28 DM.

Third Mines Branch Seminar on Environmental Improvement. Mines Branch, Dept. Energy, Mines and Resources, Ottawa. Rept. ADM 72-2. 1972. 128 p. Various scientists discuss their efforts in the control of pollution from various heat process sources.

The Tule Elk: Its History, Behaviour and Ecology. Dale R. McCullough. University of California Press, Berkeley and New York. 1971. 209 p. $10.95.

Vanishing Wings: A Tale of Three Birds of Prey. Griffing Bancroft. Franklin Watts Co., New York. 1972. 154 p. $5.95. Ornithologists stories of individual birds showing how through the food chain the poisons in insecticides picked up by aphids and earthworms can have devastating cumulative effects on eagle, falcon and osprey.

***The Violated Vision: The Rape of Canada's North.** James Woodford. McClelland and Stewart Co., Toronto. 1972. 144 p. $5.95. Canada's mindless destruction of the Arctic is the target of this angry and controversial book.

Water: The Web of Life. Cynthia A. Hunt and Robert M. Garrels. W. W. Norton, New York. 1972. 207 p. $6.95. Examines the water cycle and shows how oceans, lakes, rivers, ponds and rains form a single interlocking, always mobile system. Emphasis is on world water supplies with the U.S. used as a typical example of a developed country. The authors conclude that the future will require the comple management of water.

*Assigned for Review.

Proposed Amendments to the Constitution of THE OTTAWA FIELD-NATURALISTS' CLUB[1]

Notification is hereby given that at the next Annual Meeting of the Club it shall be moved by Dr. Ewen C. D. Todd that the Constitution shall be presented for amendment by the deletion of all the present text and the substitution of the following revised text approved by the Council. I append hereto a copy of the revised text.

(Signed)
Sheila C. Thomson
President

June 26, 1972.

CONSTITUTION OF THE OTTAWA FIELD-NATURALISTS' CLUB

Articles of the Constitution

1. Name and Status
2. Objectives
3. Membership
4. Institutions
5. Affiliated Societies
6. Benefactors
7. Patrons
8. Club Funds
9. Officers
10. The Council
11. Standing Committees
12. Auditors
13. Business Meetings
14. Elections and Appointments
15. Term of Office
16. Quorum
17. Duties of the President
18. Duties of the Vice-President
19. Duties of the Recording Secretary
20. Duties of the Corresponding Secretary
21. Duties of the Treasurer
22. Publications of the Club
23. Expulsion from the Club
24. Amendments
25. By-laws

[1]The present Constitution of the Ottawa Field-Naturalist's Club was published in the Canadian Field-Naturalist 82(3): 235-238, 1968.

Article 1. NAME AND STATUS

This Club shall be known as THE OTTAWA FIELD-NATURALISTS' CLUB. It is a non-profit organization incorporated under the laws of the Province of Ontario (1884).

Article 2. OBJECTIVES

The Objectives of this Club shall be to promote the appreciation, preservation and conservation of Canada's natural heritage; to encourage investigation and publish the results of research in all fields of natural history and to diffuse information on these fields as widely as possible; to support and co-operate with organizations engaged in preserving, maintaining or restoring environments of high quality for living things.

Article 3. MEMBERSHIP

Any persons or family shall, upon application and payment of dues, become a member of the Club. Payment of the Annual Dues as set out in the By-laws will be a necessary condition for the continuance of Membership.

(1) *Individual Membership.* A person shall be granted an Individual Membership upon payment of the annual fee, the amount of which shall be set out in the By-laws.

(2) *Family Membership.* A family shall consist of husband and wife (or either) and any dependent children up to the age of eighteen. A family shall be granted a Family Membership upon payment of the annual fee, the amount of which shall be set out in the By-laws.

(3) *Sustaining Membership.* A person or family shall be granted a Sustaining Membership upon payment of an annual fee of $25.

(4) *Life Membership.* A person shall be granted a Life Membership upon payment of a fee of $200 in a single payment for such a membership.

(5) *Honorary Membership.* Any person who has, to a marked degree, assisted toward the successful working of the Club, or who has made an outstanding contribution to Canadian natural history may be elected by the Council to Honorary Membership in the Club. The

family of an Honorary Member shall be granted the privileges of Family Membership.

(6) *Privileges of Membership.* Members may participate in the activities of the Club. Each Membership shall receive one copy of each issue of the current volume of *The Canadian Field-Naturalist,* and a copy of the Constitution and By-laws. Members, excepting dependent children, may hold office and may vote at the Annual Business Meeting or at a Special Business Meeting.

Article 4. INSTITUTIONS

Institutions cannot hold Membership in the Club but may subscribe to the publications of the Club and make donations to the Club.

Article 5. AFFILIATED SOCIETIES

Affiliated Societies are those organizations which have been accepted for affiliation by the Council. The annual affiliation fee shall be set out in the By-laws. A list of Affiliated Societies shall be published in *The Canadian Field-Naturalist.* Affiliated Societies shall receive one copy of the regular publications of the Club.

Article 6. BENEFACTORS

Benefactors shall be those persons from whom the Club shall accept the sum of $500 or more. A list of Benefactors shall be published in *The Canadian Field-Naturalist.*

Article 7. PATRONS

The Council shall have power to elect a Patron or Patrons, not to exceed two in number at any time, after his or their consent has been obtained.

Article 8. CLUB FUNDS

The Club shall maintain two permanent funds to be known as the Current Fund and the Reserve Fund.

(1) *Current Fund.* This fund shall contain the working moneys of the Club for current operations. It shall receive all normal income such as regular membership fees and any other moneys not specifically allocated to other purposes.

(2) *Reserve Fund.* This fund shall contain moneys invested so as to maximize long-term capital growth while maintaining sufficient flexibility to provide money on short notice for special requirements as needed.

Article 9. OFFICERS

The officers of the Club shall be a President, a Vice-President, a Recording Secretary, a Corresponding Secretary, and a Treasurer.

Article 10. THE COUNCIL

The Council shall consist of the officers of the Club, the Presidents of the Affiliated Societies, the Editor of *The Canadian Field-Naturalist,* the Business Manager of *The Canadian Field-Naturalist,* and a maximum of sixteen additional members. In addition to the above members, the President shall, upon his retirement, continue as a member of the Council for the ensuing Club year.

The Council shall meet from time to time at the call of the President or of any two other of its members; it shall manage all matters affecting the welfare and activities of the Club; it shall have control of the funds of the Club; it shall present at the Annual Business Meeting a report on the year's work. This report shall be published in *The Canadian Field-Naturalist.*

Article 11. STANDING COMMITTEES

Four standing committees, each consisting of at least five members, shall be appointed by the Council, namely: a Publications Committee, an Excursions and Lectures Committee, a Finance Committee, and a Membership Committee. The Chairman of each standing committee shall be chosen from among the members of the Council. The Editor of *The Canadian Field-Naturalist* and the Business Manager of *The Canadian Field-Naturalist* shall be members of the Publications Committee. The Vice-President, the Treasurer, and the Business Manager of *The Canadian Field-Naturalist* shall be members of the Finance Committee. The Chairmen of the Excursions and Lectures Committee and the Membership Committee shall have power to add to their Committees.

Article 12. AUDITORS

Two Auditors shall be elected by open vote at the Annual Business Meeting. They shall examine the Treasurer's accounts and certify as to their correctness.

Article 13. BUSINESS MEETINGS

The Annual Business Meeting of the Club shall be held in January.

A Special Business Meeting of the Club shall be called by the Recording Secretary on the request of ten voting members. The Recording Secre-

tary shall specify in the notice of meeting the nature of business to be transacted. At this meeting no business other than that for which the meeting was called shall be transacted except by unanimous decision of those present.

Article 14. ELECTIONS AND APPOINTMENTS

The officers of the Club and the additional members of the Council shall be elected annually. The nomination of sufficient persons for election to the various offices and membership of the Council shall be the responsibility of a Nominating Committee, which shall act in a manner prescribed in the By-laws.

The Council shall, at the earliest possible date, appoint:

(1) Editors and Associate Editors (as required) for *The Canadian Field-Naturalist*, and for other Club publications;

(2) A Business Manager for *The Canadian Field-Naturalist;* and

(3) Chairmen and members of Standing and Special Committees.

The Council shall have the power to accept any resignation and to appoint any member of the Club to fill any vacancy for the remainder of the original term of office.

Article 15. TERM OF OFFICE

All persons elected or appointed pursuant to Articles 10, 12 and 14 shall commence their duties at the close of the meeting at which they are elected or appointed, and shall serve until the end or the next Annual Business Meeting or until their successors are appointed.

Article 16. QUORUM

Twenty members shall constitute a Quorum at the Annual Business Meeting or at any Special Business Meeting of the Club, and seven members shall constitute a Quorum of the Council.

Article 17. DUTIES OF THE PRESIDENT

The President shall arrange, and preside at, Business Meetings of the Club and at meetings of the Council. He shall be, ex-officio, a member of all Committees of the Club.

Article 18. DUTIES OF THE VICE-PRESIDENT

In the absence of the President, or at his request, the Vice-President shall act in his stead.

Article 19. DUTIES OF THE RECORDING SECRETARY

The Recording Secretary shall keep minutes of the proceedings of the Council, the Annual Business Meeting and Special Business Meetings. He shall give previous notice to each member of the Council of its meeting and to the general membership of the Annual Business and Special Business Meetings. He shall be the custodian of the Constitution and the By-laws and of the records of the Club. He shall be the compiler of the Annual Report of the Council and shall make it available to the General Membership at the Annual Business Meeting.

Article 20. DUTIES OF THE CORRESPONDING SECRETARY

The Corresponding Secretary shall deal with the correspondence of the Club as directed by the Council.

Article 21. DUTIES OF THE TREASURER

The Treasurer shall be charged with the collection and custody of the moneys of the Club and shall keep a systematic account thereof which shall at any time be open to the inspection of the Council or of the auditors. He shall make disbursements only when authorized by the By-laws or by decision of the Council. He shall submit at each Annual Business Meeting a statement showing the financial standing of the Club.

Article 22. PUBLICATIONS OF THE CLUB

(1) *The Canadian Field-Naturalist* shall be issued as directed by the Publications Committee.

(2) Other publications shall be issued as directed by the Council.

Article 23. EXPULSION FROM THE CLUB

Any individual may be expelled from the Club for conduct or activities prejudicial to the well-being of the Club. The procedure shall be as specified in the By-laws.

Article 24. AMENDMENTS

An Amendment to this constitution may be made at an Annual Business Meeting of the Club by a two-thirds vote of the members present, notice having been sent to the Secretary, who shall present it at a meeting of the Council at least two months previous to such Annual Business Meeting, or to the Club at a previous Annual Business Meeting. Notification of a proposed Amendment

shall be published in *The Canadian Field-Naturalist* at least one month before the Annual Business Meeting at which a vote on the Amendment is to be taken.

Article 25. BY-LAWS

The Council may make By-laws that are consistent with the provisions of the Articles of this Constitution. The By-laws and any amendments thereto shall be published in *The Canadian Field-Naturalist.*

AMENDMENT TO THE BY-LAWS OF THE OTTAWA FIELD-NATURALISTS' CLUB

At a meeting of Council on June 19, 1972, it was agreed that section 9 of the by-laws should be deleted and the following substituted therefor:

"9. *Fees.* The schedule of annual fees shall be as follows:

Members:

Individual	$7.00	(receives the *Canadian Field-Naturalist;* also *Trail & Landscape* if local member. *Trail & Landscape* to be sent to outside member on request.)
Family	$9.00	(receives one copy per household of the *Canadian Field-Naturalist;* also one copy of *Trail & Landscape* if local member. *Trail & Landscape* to be sent to outside member on request.)
Affiliated Societies	$20.00	
Institutional Subscriptions		The *Canadian-Field Naturalist* ...... $12.00 *Trail & Landscape* .... $ 5.00

These fees shall take effect January 1, 1973. Fees become due at the beginning of each calendar year. No member in arrears shall be entitled to the privileges of the Club."

A. W. Rathwell,
Secretary.

Information Governing Content of The Canadian Field-Naturalist

Feature Articles

Beginning with the 1970 issues, the Canadian Field-Naturalist has been open for the consideration of major feature articles whose purpose is to make authoritative reviews of outstanding natural history and/or environment issues of our time. If possible, feature articles should be illustrated. Publication costs are open for negotiation between the author, editor and the business manager of the club.

Articles

The Canadian Field-Naturalist is a medium for publication of research papers in all fields of natural history. Reviews, compilations, symposia, controversial or theoretical papers, historical researches, etc. can also be published. Environmentally related papers are given some priority in publication sequence.

News and Comment

Informed naturalists, biologists and others are invited to present documented narratives and commentaries upon current scientific and political events that affect natural history and environment values. This section deals with activities, policies, and legislation relating to land and resource use, national and provincial parks, pollution, natural science education, conservation, natural area and species preservation activites and so on. Contributions should be as short as possible and to the point.

Notes.

Short notes on natural history and environment written by naturalists and scientists are welcome. Extensions of range, interesting behavior, pollination observations, reproductive phenomena, oil and pesticide pollution statistics and many other kinds of natural history observations may be offered. However, it is hoped that naturalists will also support local natural history publications.

Letters

Letters commenting on items appearing in this journal or on any developments or current events affecting natural history and environment values are welcome. These should be brief, clear, pertinent and of interest to a wide audience.

Reviews

Normally, only solicited reviews are published. The editor invites biologists and naturalists to submit lists of titles (complete with pertinent information regarding authors, publisher, date of publication, illustrations, number of pages and price) for listing under "Other New Titles".

Special Notices and other items

The Canadian Field-Naturalist has a flexible publication policy. Hence an item not falling under any of our traditional sections can be given a special place provided that it is judged suitable.

(See Instructions to Contributors inside back cover)

Instructions to Contributors

Manuscripts

Authors should submit two manuscripts (original and carbon copy), each complete with abstract, tables, and illustrations. Manuscripts should be typewritten on paper measuring 8½ x 11 inches. All text matter, including quotations, footnotes, tables, literature citations and captions for figures should be double-spaced. Words meant to appear in italics should be underlined. Every sheet on the manuscript should be numbered.

Literature citations should be listed alphabetically according to author and should be placed immediately after the main body of the text in all manuscripts except in letters to the editor. In no case should any words be abbreviated; this includes references to tables and figures as well as literature citations.

The tables should be titled and numbered consecutively in arabic numerals. Tables should be placed each on a separate page after the Literature Cited. Captions to figures should be typed together on one page. Authors are requested to use at least one given name.

The **Style Manual for Biological Journals** is recommended, in general, as a guide to contributors.

Webster's New International Dictionary is the authority for spelling. However, in a case of difference in the spelling of a common name, and in the use of a variant name, a decision of a learned society is preferred.

The order in which papers are published will be as determined by the editor.

Illustrations

All illustrations should be numbered consecutively in arabic numerals. The author's name, title of the paper, and figure number should be written in the lower left corner of the sheet on which each illustration appears. The caption should **not** appear on the illustration.

Line drawings should be made with India ink on white, good quality drawing paper, blue tracing linen, or good quality blue-lined co-ordinate paper. Coordinate lines that are to appear on the reproduction should be ruled in black ink. Descriptive matter should be lettered, not typewritten, and all parts of the drawing should permit easy legibility even if a reduction is made.

Photographs should have a glossy finish and show sharp contrasts. For reproduction as a complete plate they should be mounted without space between prints.

For large drawings and mounted photographs the ratio of height to width should conform to that of the printed journal page (ratio of 45 up to 35 across) or roughly 7½ × 5¾ inches, but the height should be adjusted to allow for the caption if the caption is to go on the same page.

Special Charges

Authors must share in the cost of publication by paying $22.00 for each page in excess of six journal pages.

Page charges are separate from charges for illustrations and tables.

Illustrations cost $6.50 for the first five square inches plus 45 cents for each additional square inch. Tables cost up to $22.00 per page, depending upon size. The special charges for illustrations and tables are *in addition to* all charges that are levied for pages in excess of six.

Reviewing Policy of the Canadian Field-Naturalist

Articles and Notes offered for publication to the Canadian Field-Naturalist are normally sent to the Associate Editor and one other reviewer. Certain Articles receive the benefit of three or four reviews. Short Notes are reviewed by Associate Editors.

Reprints

Reprints, with or without covers may be purchased. These should be ordered at the time the galley proof is returned to the editor. Members in good standing can request a 10% reduction in reprint costs.

Schedule of charges for reprints

Number of Reprints	1 to 4 journal pages	5 to 8 journal pages	9 to 12 journal pages	13 to 16 journal pages	17 to 20 journal pages	Additional charge for Mayfair covers
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Cover photograph: American Golden Plover on nest, Cape Henrietta Maria, Ontario (see page 333). Photo courtesy of George K. Peck.

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Birds of The Cape Henrietta Maria Region, Ontario

George K. Peck

68 Barringham Dr.,
Oakville, Ontario

Abstract. The peninsula of Cape Henrietta Maria, situated at the westerly junction of Hudson and James Bays and that area of land and water within 25 miles of its base, is the region involved in this study. This treeless, coastal area is a southern extension of sub-arctic tundra, as is reflected by its avifauna.

The 94 bird species occurring in this region consist of 35 known breeding species, 10 probable breeding species, 30 summer visitors (non-breeders and accidentals), 18 arctic-breeding migrants, and one winter resident.

The status of each species is reviewed using literature sources, personal communications, the Ontario Nest Records Scheme (O.N.R.S.), and observations made by the author during a field trip in the summer of 1970. The first Ontario nest records for Arctic Loon (*Gavia arctica*) and Snow Goose (*Chen caerulescens*), and the first Ontario breeding and nest record for the American Golden Plover (*Pluvialis dominica*), are reported.

Cape Henrietta Maria is a peninsula about seven miles in length, situated in the Hudson Bay Lowlands. It lies immediately north of the 55th parallel at the westerly junction of Hudson and James Bays.

The Cape Henrietta Maria region, for the purposes of this paper, is that area of land and water contained by a circle with a 25 mile radius centred at the base of the Cape (see Figure 1). This area, which lies within the recently designated boundaries of Polar Bear Provincial Park, was chosen partly because it is in the tundra region of Ontario, because it includes the sites of previous ornithological field work, and primarily in order to procure nesting information of its characteristic breeding birds. This information was needed for the Ontario Nest Records Scheme (O.N.R.S.) and for the detailed summary of its records, currently in preparation by R. D. Montgomerie and the author, dealing with the nidiology and breeding distribution of the birds of Ontario.

The huge expanse of arctic water which comprises Hudson and James Bays exerts its chilling influence along a narrow zone of Ontario's seacoast to produce a low-latitude tundra biome. The resulting sub-arctic Cape Henrietta Maria region encloses the major portion of Ontario's only tundra (see Figure 2). The flatness of this strip of coastal tundra is broken by gravel eskers and by strand lines of the former marine beaches of Hudson and James Bays. In some places as many as 75 beaches can be counted within 20 miles of the present shore of Hudson Bay, according to Lumsden (*in* Judd and Speirs, 1964). The glacier-carved hollows between the eskers and beach-lines are filled by innumerable shallow lakes. The various gravel ridges and areas of higher ground, never more than 100 feet above sea-level, support a heath-lichen complex. On the more poorly-drained, lower areas between the ridges, sedges are the typical vegetation. Dense stands of dwarf willow and birch border the streams and numerous sloughs and fill in many protected hollows on the tundra. Each of these habitats is particularly favoured by certain bird species for their nest sites. The Cape region's environment attracts several arctic-breeding birds that are known to nest only here in Ontario, and it is likely that some of these species reach their southern breeding limit in this region.

The Cape proper was visited by United States Fish and Wildlife Service personnel in 1944. T. H. Manning camped on the Cape from July 19-26, while working for the Geodetic Service of Canada in the summer of 1947, and his observations provided some important ornithological information on the area (Manning, 1952). The observations of W. Spreadborough in 1904 (Macoun and Macoun, 1909), referred to by Manning and others, are not included here as it is felt that his trip along the west coast of James Bay did not take him into the study region. The Royal Ontario Museum (R.O.M.) collecting trip by C. E. Hope *et al.*, in June, July and August, 1948, was based near the southern boundary of the study region (see

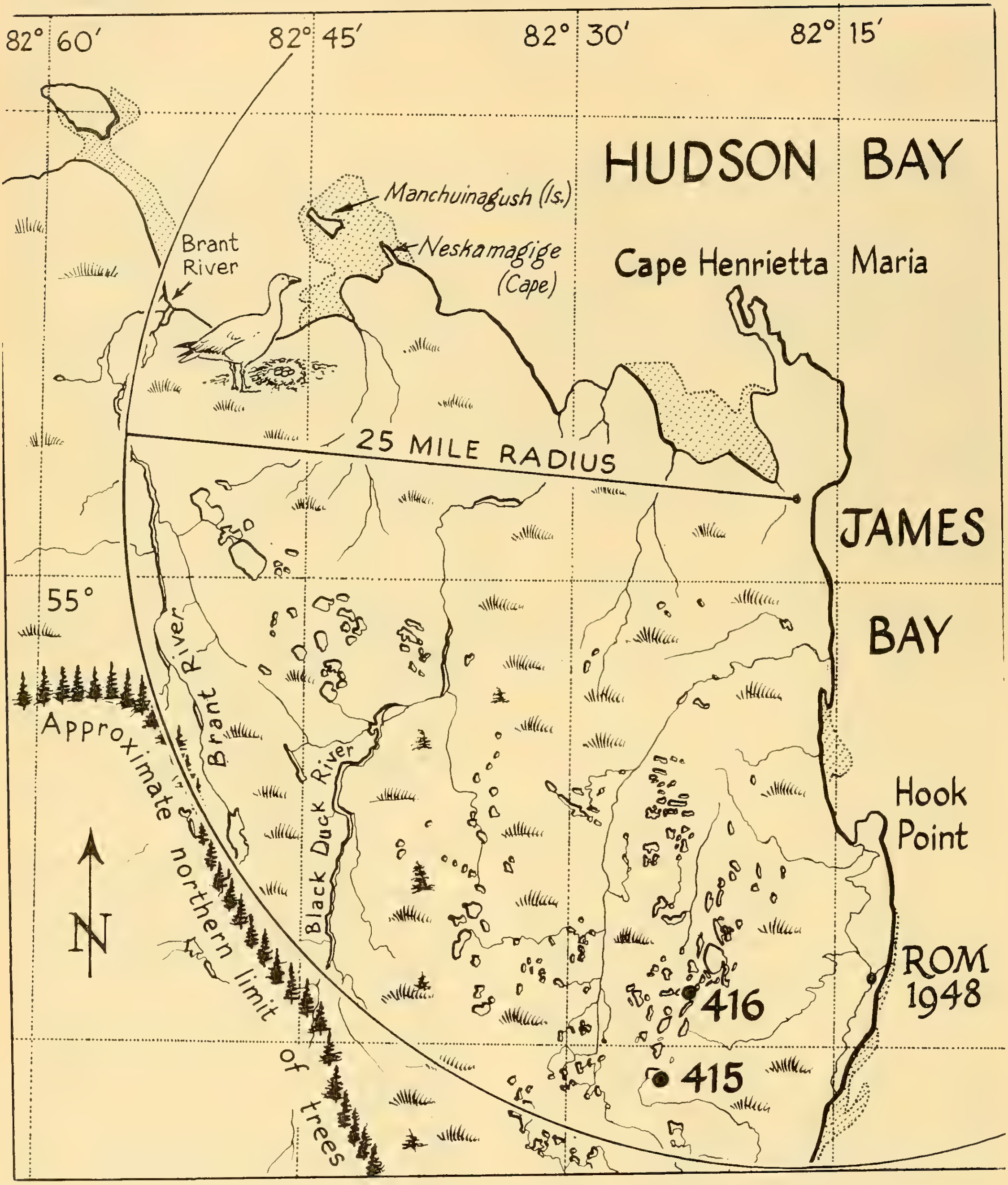

FIGURE 1. The Cape Henrietta Maria Region, Ontario.

FIGURE 2. Cape Henrietta Maria peninsula, south-eastern aspect on June 22, 1970.

Figure 1). H. G. Lumsden of the Ontario Department of Lands and Forests has made summer visits almost yearly since 1956 to a large, straggling Snow Goose (Blue Goose) colony, most of which is within the study region, between the Cape and the mouth of the Brant River (see Figure 1). The abandoned radar sites 415 and 416 (see Figure 1) have been visited by a small number of field expeditions in recent years. These include the collecting trip by Dr. C. M. Young for Laurentian University in August, 1968, the investigational survey of G. O'Reilly (1969) for the Ontario Department of Lands and Forests in July, 1969, and a trip by S. J. Peck, Paul Geraghty, and the author, under the auspices of the Department of Ornithology, R.O.M., and the Canadian Wildlife Service, in June and July, 1970 (Peck, 1970a).

For certain species, breeding information in the Cape region has been obtained through the use of the Ontario Nest Records Scheme (O.N.R.S.), housed in the Department of Ornithology, R.O.M., Toronto, Ontario.

The nomenclature used in the following annotated list follows that of the American Ornithologists' Union Check-List (1957), except that Snow and Blue geese are considered to be conspecific (Cooch, 1961). With few exceptions (e.g. Canada Goose) the lack of sufficient specimen evidence precluded the use of subspecific names.

COMMON LOON. *Gavia immer.* Summer occurrences in the Cape region would appear to be those of nonbreeding birds. Five individuals were seen at Cape Henrietta Maria from July 20-25, 1947 (Manning, 1952), and three by the 1948 Royal Ontario Museum (R.O.M.) field party near their camp-site 20 miles south of the Cape (Hope, 1948). Two Common Loons

FIGURE 3. Adult Arctic Loon (*Gavia artica*) on nest near radar site 416, Cape Henrietta Maria region on June 29, 1970.

were observed on Hudson Bay near (Cape) Neskamagige on July 13, 1957 (Lumsden, 1957a), and O'Reilly (1969) saw the species in the Brant River area between July 23 and 31, 1969. It was observed near radar site 416 in August, 1968 (Young, pers. comm.), although we saw none there in 1970.

ARCTIC LOON. *Gavia arctica.* An adult male attending a young bird was collected on August 16, 1944, ten miles off Cape Henrietta Maria by R. H. Smith of the United States Fish and Wildlife Service, and is in the R.O.M. (Baillie, 1961). Five were observed at the Cape between July 20 and 25, 1947 (Manning, 1952), and a number were seen and a few including downy young, collected by the 1948 R.O.M. field party (Hope, 1948). Lumsden (1957a) noted two at Neskamagige on July 15 and two at Manchuinagush (Island) on July 16, 1957. This species was seen and collected near radar site 416 in August, 1968 (Young, pers. com.), and observed in July, 1969 at radar site 415 (O'Reilly, 1969).

Nesting of the Arctic Loon in the Cape region was confirmed with our finding of the first observed nests, six in all, each with two eggs, between June 23 and July 2, 1970, in the immediate vicinity of radar site 416 at 54°47′N and 82°22′W (Peck, 1970b). We noted pairs daily between June 22 and July 4 and most of the larger lakes had a pair present. All six of the nests we found were within two miles of each other. Photographs were taken of three of the nests and an incubating adult (see Figure 3).

RED-THROATED LOON. *Gavia stellata.* Five were observed and two were collected by the 1948 R.O.M. field party (Hope, 1948). From July 13-14, 1957, three were seen at Neskamagige (Lumsden, 1957a). The status of this bird as a breeding species in the Cape region was established by D. W. Simkin of the

Ontario Department of Lands and Forests, who photographed two adults with two downy young (photograph in R.O.M.) on July 29, 1966, west of the Cape and one mile from the shore of Hudson Bay at 55°7′N and 82°43′W. Simkin had previously flushed an adult from a nest with two eggs on August 3, 1962 at 55°15′N and 84°W, outside the Cape region, but on that occasion he did not procure any material evidence of his find (Simkin, 1968). We saw two adult Red-throated Loons near radar site 416, one on June 22 and one on June 23, 1970.

GREAT BLUE HERON. *Ardea herodias.* A single adult was seen on August 16, 1948 by the R.O.M. field party (Hope, 1948).

AMERICAN BITTERN. *Botaurus lentiginosus.* The 1948 R.O.M. field party heard and saw several individuals of this species and one was collected on July 5 (Hope, 1948). Two were flushed from willow cover along the bank of the Black Duck (Mukateship) River, 20 miles southwest of Cape Henrietta Maria on July 22, 1957 (Lumsden, 1957a). This species was seen in August, 1968 near radar site 416 (Young, pers. comm.).

WHISTLING SWAN. *Olor columbianus.* According to Manning (1952) this species has seldom been observed in the James Bay area. One was seen in August, 1968 just outside the southern boundary of the Cape region (Young, pers. comm.), and one other noted inside the Cape region in July, 1969 at radar site 415 (O'Reilly, 1969). Lumsden (pers. comm.) observed two on the Cape peninsula on June 21, 1971, and saw two others on a lake just west of the forks of the Brant River on June 26 and again on July 22, 1971.

CANADA GOOSE. *Brant canadensis.* In 1948 numbers were seen south of the Cape by the R.O.M. field party (Hope, 1948), and on July 13 and 22, 1957 at Neskamagige (Lumsden, 1957a). The presence of a brood of young near radar site 416 on June 27, 1964, and an empty, probably predated nest near the mouth of the Brant River on July 25, 1969 (Lumsden, pers. comm.), established this species as a breeding bird in the Cape region. Canada Geese were seen and some collected in August, 1968 near radar site 416 (Young, pers. comm.), and we saw adults singly and in groups of three to 12 individuals on the tundra almost daily from June 22 to July 2, 1970 near radar sites 415 and 416.

On July 14, 1957 a flightless specimen of the race *Branta c. hutchinsii* was collected about five miles west of Neskamagige (Lumsden, 1957a).

BRANT. *Branta bernicla.* According to reports from employees of the Hudson Bay Company, Brant migrate past Cape Henrietta Maria on their way south every year (Lewis, 1937). On July 12, 1957 at Neskamagige, on the coast west of the Cape, a flock of 157 were seen by Lumsden (1959a).

SNOW GOOSE (Blue Goose). *Chen caerulescens.* In the Cape region the subspecies *Chen c. caerulescens*, in its white and blue colour phases, has established one of its southernmost breeding colonies in Canada. Mixed pairs and a mixed flock of both colour phases were seen and several individuals collected in July, 1947, at the Cape and 25 miles farther south on the coast (Manning, 1952). During a reconnaissance flight in June, 1950 A. S. Hawkins, E. G. Wellein, and W. F. Crissey of the United States Fish and Wildlife Service observed three downy young with two adult white phase birds on Cape Henrietta Maria (Williams, no date).

On July 11, 1956 during a reconnaissance flight west of the Cape, N. Perret of the Canadian Wildlife Service and H. G. Lumsden of the Ontario Department of Lands and Forests saw mixed pairs of these geese with downy and half-grown young. Three groups were observed on the 55°7′N parallel at 82°32′W, 82°41′W and 82°47′W (Lumsden, 1957b). This colony was first established in 1947, when an undetermined number of pairs nested at the south end of (Lake) Kawinabiskak, near the Hudson Bay coast, less than ten miles west of the Cape. This was the most easterly point that breeding occurred in the region (Lumsden, 1959a). From July 4-7, 1957 H. G. Lumsden and J. A. Metat visited this colony again, collected four downy young, and noted that the colony was much larger than in 1956, totalling some 17, 334 birds (Bennett *et al*, 1958; Lumsden, 1959a).

Athough Lumsden (pers. comm.) has been photographing this colony almost annually since 1957, we took the first recorded photographs of nests with determinable egg numbers in this colony, from an aircraft at a height of about 50 feet. These photographs were taken at 55°7′N and 82°48′W, near the Hudson Bay coast and within four miles of the mouth of the Brant River on June 22, 1970 (Peck, 1970b). We noted pairs of both colour phases as well as mixed pairs. The blue phase birds predominate in this colony and have increased from 68% of the population in 1957 to 78% in 1970, at which time the population of both phases was estimated to be about 40,000 birds (Lumsden, pers. comm.).

A single individual of the race *Chen c. atlantica* was collected at the mouth of the Brant River on July 20, 1970 by Lumsden (pers. comm.).

MALLARD. *Anas platyrhynchos.* This species, which probably breeds in the Cape region, was noted by the 1948 R.O.M. field party who saw several and on July 19 collected a female (Hope, 1948). Lumsden (1957a) observed a few on July 13 and 14, 1957 at Kawinabiskak and Neskamagige and on July 22 saw 66 birds along 16 miles of the Black Duck River. Also on July 22, 1957 broods of this species and Black Ducks (*Anas rubripes*) were observed from a helicopter 25 miles inland from the Hudson Bay coast, just outside the Cape region (Lumsden, 1959a). Mallards were observed near radar site 416 in August,

1968 (Young, pers. comm.), and we saw an adult there on June 22, 1970.

BLACK DUCK. *Anas rubripes.* This species, like the preceding, probably also breeds within the Cape region. It was seen in fairly large numbers and several were collected by the 1948 R.O.M. field party (Hope, 1948). In late June and most of July, 1957 the Black Duck was the second commonest duck species seen along the Hudson Bay coast (Lumsden, 1957a). During this same period 15 flightless males were caught in the area and on July 22 broods of Black Ducks and Mallards (*Anas platyrhynchos*) were noted from a helicopter 25 miles inland from Hudson Bay, just outside the Cape region (Lumsden, 1959a). Black Ducks were observed near radar site 416 in August, 1968 (Young, pers. comm.), and at the same area by us in June and July, 1970. We noted several flightless adults in this period.

PINTAIL. *Anas acuta.* The Pintail is easily the most abundant of the surface-feeding ducks in the Cape region, and was seen in numbers, collected, and observed breeding in 1947 (Manning, 1952), and in 1948 (Hope, 1948). In 1957 numbers were seen on July 13 at Kawinabiskak, on July 14 at Neskamagige, and on July 22 on the Black Duck River (Lumsden, 1957a).

At radar site 416 Young (pers. comm.) collected some and observed evidence of breeding in August, 1968, and in 1970 we saw many throughout the region and noted them daily at radar site 416. On June 25 we flushed a female from a nest with five eggs, near radar site 415. On June 27 this nest contained seven eggs.

GREEN-WINGED TEAL. *Anas carolinensis.* This is one of the commonest ducks in the Cape region, and almost undoubtedly breeds there. It was observed and collected in 1948 south of the Cape (Hope, 1948), and Lumsden (1957a) noted 16 birds on the Black Duck River on July 22, 1957. Green-winged Teals were seen and collected in August, 1968 at radar site 416 (Young, pers. comm.), and we saw them there on several occasions and notably watched five drakes in breeding plumage on a small lake on June 29, 1970.

AMERICAN WIDGEON. *Mareca americana.* On July 26, 1948 the R.O.M. field party collected a downy young of this species about 20 miles south of the Cape, thus establishing it as a breeding species in the region (Hope, 1948). It is apparently not common, and to date has not been reported from radar sites 415 and 416.

SHOVELER. *Spatula clypeata.* There is a single sight record of this duck on August 16, by T. M. Shortt of the 1948 R.O.M. field party (Hope, 1948).

GREATER SCAUP. *Aythya marila.* In 1948 the R.O.M. field party observed and collected fair numbers of this species. Two groups of downy young accompanied by female adults were collected to establish the first breeding record for the province of Ontario (Hope, 1948). In 1957 this species was noted on July 14 at Neskamagige, on July 15 at Kawinabiskak, and on July 22 on the Black Duck River and at Cape Henrietta Maria (Lumsden, 1957a). The species was collected in August, 1968 near radar site 416 (Young, pers. comm.), and we noted in the same area at least two pairs on June 22, 1970 and possibly others on occasion in the company of Lesser Scaups (*Aythya affinis*).

LESSER SCAUP. *Aythya affinis.* This species was apparently not noted on the coast in the Cape region by either Manning in 1947 or the R.O.M. field party in 1948. It was observed and collected near radar site 416 on August 11, 1968 (Young, pers. comm.), and we saw small groups of both sexes there on six of the nine days between June 22 and 30, 1970.

COMMON GOLDENEYE. *Bucephala clangula.* In the treeless region of the Cape during the breeding season, non-breeders are relatively common. They were observed south of Cape Henrietta Maria on July 19, 1947 (Manning, 1952), and on July 30, 1948 (Hope, 1948). Many flocks, including flightless birds, were seen off Manchuinagush on Hudson Bay on July 16, 1957 by Lumsden (1957a) who noted that numbers of sub-adults and adult males summer along the region's Hudson Bay coast. The species was seen and collected near radar site 416 in August, 1968 (Young, pers. comm.), and we observed small flights there on June 23 and 25, 1970.

BUFFLEHEAD. *Bucephala albeola.* In 1970 we saw a flock of three females and a drake of this tree-nesting species, near radar site 416 on June 30. Two males and fifteen females were observed by Lumsden (pers. comm.) at radar site 415 on October 16, 1971.

OLDSQUAW. *Clangula hyemalis.* Although relatively few nests of this abundant species have been found, it undoubtedly breeds throughout the Cape region. At Cape Henrietta Maria between July 19 and 25, 1947, T. H. Manning saw and collected Oldsquaws and also found two nests with eggs which would probably have hatched about July 26 (Manning, 1952). Twenty adults, a set of three eggs on July 10, and a brood of four downy young on July 13, were collected by the 1948 R.O.M. field party (Hope, 1948). At Cape Henrietta Maria Lumsden (1957a) noted 24 birds on July 22, 1957. Near radar site 416 in August, 1968, Oldsquaws were seen and collected (Young, pers. comm.), and at radar site 415 in July, 1969, they were found nesting (O'Reilly, 1969). We found this duck to be the most common waterfowl species in 1970 at radar site 416, where we observed many pairs and individuals of both sexes daily, although no nests were seen.

COMMON EIDER. *Somateria mollissima.* Many were seen in July, 1947; at the Cape where a few may breed (Manning, 1952). A skeleton was collected be-

low the Cape by the 1948 R.O.M. field party (Hope, 1948). According to Lumsden (pers. comm.) they are always present on an island just west of the Cape peninsula in summer, and in 1957 (Lumsden, 1957a) he noted eight females along the Hudson Bay coast west of the Cape between July 12 and 22.

KING EIDER. *Somateria spectabalis*. At the Cape on August 23, 1944, H. R. Smith of the United States Fish and Wildlife Service, collected a female King Eider (specimen in R.O.M.) attending six young, thus establishing the first Ontario breeding record (Baillie, 1961). In July, 1947, about 200, including four females with young were seen in the vicinity of the Cape (Manning, 1952). Lumsden (1957a) saw three males at Manchuinagush on July 12, 1957 and three females and a male at Neskamagige on July 14. The male was collected.

WHITE-WINGED SCOTER. *Melanitta deglandi*. This species was apparently seen on Hudson Bay west of the Cape on July 27, 1947 (Manning, 1952), and numbers were seen and the skeletal remains of one were secured south of the Cape in 1948 (Hope, 1948). Some flocks were observed on July 16, 1957 at Manchuinagush (Lumsden, 1957a). Two males were seen on June 15, 1965 near radar site 415 (Lumsden, pers. comm.), and we saw small groups and more often pairs on June 22, 27, 29 and July 1, 1970 near radar site 416. Three pairs were observed near radar site 416 on June 27, 1971 (Lumsden, pers. comm.).

SURF SCOTER. *Melanitta perspicillata* and
COMMON SCOTER. *Oidemia nigra*. Unseparated sight records of flocks of both the above species were recorded west of the Cape on July 25 and 26, 1947 (Manning, 1952). Many flocks of Common Scoters were observed at Manchuinagush on July 16, 1957 (Lumsden, 1957a). Godfrey (1966) states that both species summer regularly on the coasts of Hudson and James Bays.

COMMON MERGANSER. *Mergus merganser*. A single adult male of this species was seen on July 17, 1948, south of the Cape, by the R.O.M. field party (Hope, 1948). Another was seen near the mouth of the Brant River on July 15, 1966 (Lumsden, pers. comm.).

RED-BREASTED MERGANSER. *Mergus serrator*. Two small flocks were observed and one individual was collected in July, 1948, south of the Cape (Hope, 1948). The species was observed near the mouth of the Brant River on July 19, 1969 (Lumsden, pers. comm.).

ROUGH-LEGGED HAWK. *Buteo lagopus*. On August 7, one was observed south of the Cape by the 1948 R.O.M. field party (Hope, 1948). The hearsay 1958 breeding record of this species at radar site 416 (Baillie, 1963) remains questionable due to a lack of material evidence. At radar site 415 five were seen on July 23, 1960, and the species observed there again on June 16, 1965 (Lumsden, pers. comm.). It was noted in the Brant River area in July, 1969 (O'Reilly, 1969), and a single bird seen just east of the mouth of the Brant on July 23, 1971 (Lumsden, pers. comm.).

GOLDEN EAGLE. *Aquila chrysaetos*. The R.O.M. was given the feet of a Golden Eagle stated to have been shot on April 10, 1938, a few miles inland from the Cape, by an Indian. The donor, Jack Rodgers of Lake River, further informed the R.O.M. that the bird was shot at its nest in a pine tree (Snyder, 1940). As tree-line is almost 30 miles from the Cape, the record remains somewhat uncertain. In this regard, Lumsden (1964a) reports hearing of a nest of this species in a tree at the junction of the Aquatuk and Sutton rivers which he feels is likely to be the true locality of the above record. Since the junction of the two rivers is about 72 miles from the Cape, this location is far outside the study region.

MARSH HAWK. *Circus cyaneus*. The Marsh Hawk probably breeds on the tundra in the Cape region. Several, including four immatures on August 16, were observed by the 1948 R.O.M. field party (Hope, 1948). The species was seen near radar site 416 in August, 1968 (Young, pers. comm.), and we observed a single female daily at this same location from June 26 to July 1, 1970. A male was seen by Lumsden (pers. comm.) east of the mouth of the Brant River on July 23, 1971.

OSPREY. *Pandion haliaetus*. Lumsden (pers. comm.) saw two birds at the Brant River, six miles from the coast of Hudson Bay, on July 14, 1969, and one at the mouth of the Brant River on August 2 of the same year.

PEREGRINE FALCON. *Falco peregrinus*. On June 22, 1970 we investigated by aircraft, for the Canadian Wildlife Service (Cade and Fyfe, 1970), the alleged sites of three Peregrine Falcon eyries. We found no birds or eyries and to date there have been no reliable sightings of this species reported in the Cape region.

PIGEON HAWK. *Falco columbarius*. Several were seen in the summer of 1948 by the R.O.M. field party, and a female was collected on August 8, south of the Cape (Hope, 1948).

WILLOW PTARMIGAN. *Lagopus lagopus*. Although Manning (1952) stated that there were no modern records of this species breeding in the Cape region, the Willow Ptarmigan is an abundant, permanent resident of this treeless area. Many individuals were seen and collected by the 1948 R.O.M. field party, including a set of eight eggs on July 7 (Hope, 1948). At radar site 415 in 1966, and near the mouth of the Brant River in 1969 and 1970, H. G. Lumsden recorded nests and eggs of this species (O.N.R.S.). Newly-fledged young were observed in August, 1968 near radar site 416 (Young, pers. comm.), and at radar site 415 in July, 1969, nesting was also observed (O'Reilly, 1969).

At radar site 416, territorial males, sometimes accompanied by feeding females, were seldom out of our

sight or hearing in 1970. We noted them daily from June 22 to July 4, 1970 and found eight nests containing from one to 12 eggs, in the immediate area, between June 23 and 29.

ROCK PTARMIGAN. *Lagopus mutus.* Lumsden (1964b) was told that this species occurs regularly in winter on Cape Henrietta Maria, and that birds were present in 1960-61 and 1961-62.

SANDHILL CRANE. *Grus canadensis.* Lumsden (1971) was told of a sighting of three cranes on June 8, 1960, about 16 miles from the Hudson Bay coast, near the Brant River. This approximate location is near or within the Cape region.

SORA. *Porzana carolina.* A female was collected on July 9, 1948 by the R.O.M. field party, 20 miles south of the Cape (Hope, 1948).

YELLOW RAIL. *Coturnicops noveboracensis.* Numbers were heard and seen by the 1948 R.O.M. field party, and on July 8, T. M. Shortt of that group, collected a male and found several, large fragments of eggshell which were readily identifiable (Hope, 1948). These specimens are in the R.O.M.

SEMIPALMATED PLOVER. *Charadrius semipalmatus.* This abundant shorebird in the Cape region finds ideal breeding habitat on the extensive, raised gravel beaches, so characteristic of much of the area. Manning (1952) found the species very numerous on the Cape, and between July 20 and 24, 1947 he observed over 200 adults and some 15 running young, and of these, three adults and three downy young were collected. The 1948 R.O.M. field party saw at least 50 individuals and collected 12, including a juvenile. Two nests with eggs were found on June 26 and 27 (Hope, 1948). On July 12 and 13, 1957 at Neskamagige and Kawinabiskak several birds were observed (Lumsden, 1957a). At radar site 415, H. G. Lumsden found a nest and four eggs on June 28, 1964 (O.N.R.S.). The species was observed and collected by Young (pers. comm.) in August, 1968 near radar site 416, and it was seen at radar site 415 in July, 1969 (O'Reilly, 1969).

We noted this plover daily within a few miles of radar site 416 from June 22 to July 4, 1970, and particularly studied four breeding pairs, three of whose nests we photographed in the area.

KILLDEER. *Charadrius vociferus.* The 1948 R.O.M. field party found a skull of this species on July 7, south of the Cape, and observed a single individual on August 12 (Hope, 1948). Killdeer were noted at radar site 415 on June 28, 1964 (Lumsden, pers. comm.).

AMERICAN GOLDEN PLOVER. *Pluvialis dominica.* This shorebird appears to be at least moderately common in the Cape region, judging from the number of reported observations. The 1948 R.O.M. field party saw several dozen individuals, some of which were undoubtedly migrants, and they collected 24 birds (Hope, 1948). This species was seen near radar site 415 in August, 1968 (Young, pers. comm.), and in July, 1969 both at radar site 415 and in the Brant River area by O'Reilly (1969). Lumsden (pers. comm.) observed this plover near radar site 415 also, and on July 23, 1970 at the mouth of the Brant River, he noted fall migrants for the first time that year.

The inclusion of this species on the list of Ontario's breeding birds, resulted from our discovery of a nest and four eggs on June 23, 1970 near radar site 415 at 54°44′N and 82°24′W (Peck, 1970c). The site, eggs and adults were photographed (see Figure 4) and the nesting birds studied daily until June 28. Photographs of the nest and eggs and an incubating adult, are on file at the R.O.M.

BLACK-BELLIED PLOVER. *Squatarola squatarola.* This species in the Cape region has been observed only as a coastal migrant. A few were seen by the 1948 R.O.M. field party and one was collected (Hope, 1948).

RUDDY TURNSTONE. *Arenaria interpres.* This species appears in the Cape region only as a migrant. A flock of 15 was observed at the Cape on July 23, 1947 (Manning, 1952). Numbers were seen, including several in juvenal plumage on August 15, 1948, and four were collected (Hope, 1948). Young (pers. comm.) observed and collected the species near radar site 416 in August, 1968. Turnstones were noted at the mouth of the Brant River on July 30, 1969 by Lumsden (pers. comm.), who has observed them there each year in late July.

COMMON SNIPE. *Capella gallinago.* The coastal barrens and tundra of the Cape region would seem to have few breeding Common Snipes, although they have been found nesting near tree-line both south and northwest of the area (O.N.R.S.). A total of 18 was observed by the 1948 R.O.M. field party in the region (Hope, 1948). This species was seen in August, 1968, near radar site 416 (Young, pers. comm.), and in July, 1969, near radar site 415 and in the Brant River area (O'Reilly, 1969). We heard snipe winnowing near radar site 416 on June 26, 1970 and observed a single bird there on July 1.

WHIMBREL. *Numenius phaeopus.* Although Manning (1952) collected a pair of Whimbrels and their three downy young on July 17, 1947, south of the Cape region at Lake River, he did not observe them in the study area. Many were seen and collected and two nests with eggs were found by the 1948 R.O.M. field party (Hope, 1948). In June and July, 1957 on the Hudson Bay coast, Lumsden (1957a) found Whimbrels abundant and observed them daily, although no nests or young were seen. This species was observed near radar site 416 in August, 1968 (Young, pers. comm.), and at radar site 415 in July, 1969 (O'Reilly, 1969).

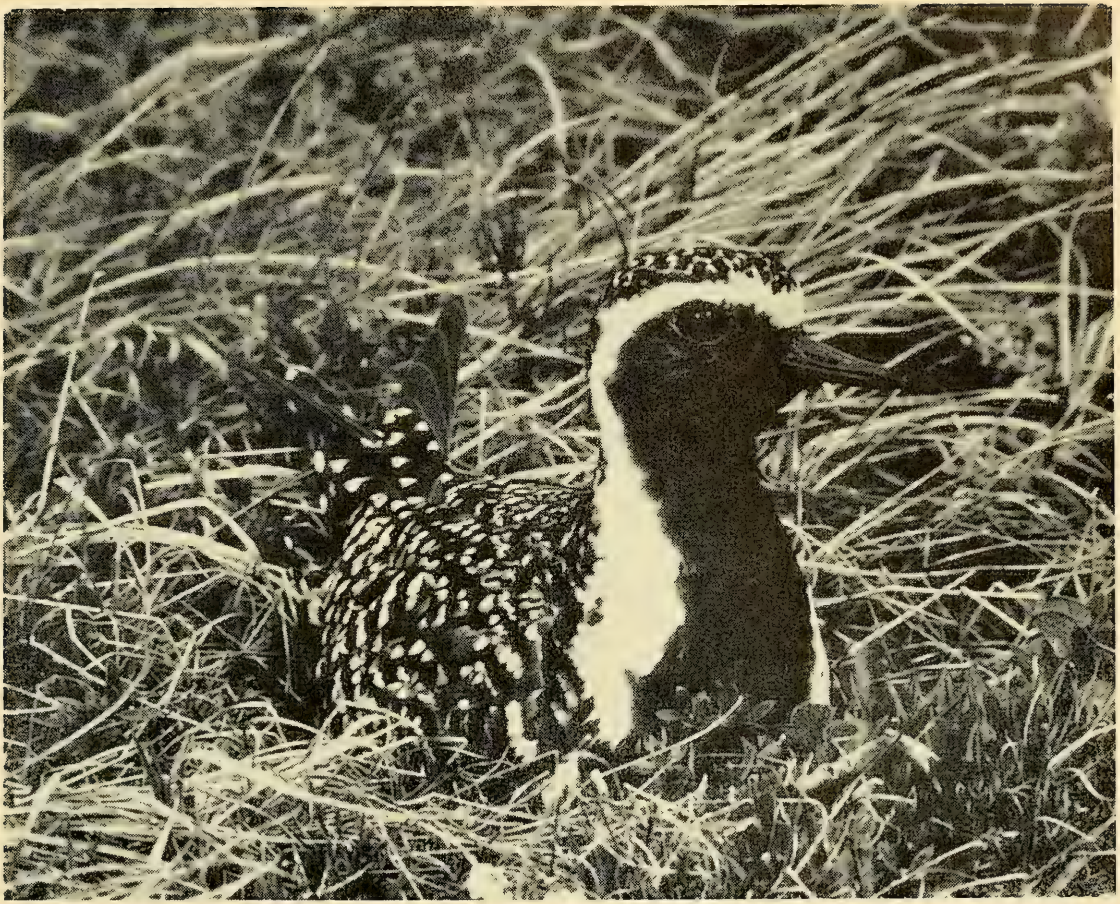

FIGURE 4. Adult male American Golden Plover (*Pluvialis dominica*) on nest near radar site 415, Cape Henrietta Maria region on June 25, 1970. This the first Ontario breeding record.

We found a Whimbrel's nest with three eggs on an area of wet tundra immediately east of the gravel air-strip at radar site 415 on June 25, 1970, and photographed and studied the adults at this nest daily until June 29.

SPOTTED SANDPIPER. *Actitis macularia.* Although the Spotted Sandpiper has been found nesting near tree-line, south, west and northwest of the Cape region (O.N.R.S.), its nest has not been found on the tundra of the study area. A single juvenile bird was observed by the 1948 R.O.M. field party on August 11 (Hope, 1948), and the species was seen and collected near radar site 416, also on August 11 in 1968 (Young, pers. comm.). Lumsden (pers. comm.) noted it every few miles along the Brant River near its mouth, on July 29, 1969, and has observed it in that area each year.

GREATER YELLOWLEGS. *Totanus melanoleucus.* A total of 25 Greater Yellowlegs in small flocks was seen between July 20 and 24, 1947 at Cape Henrietta Maria (Manning, 1952). The 1948 R.O.M. field party saw over 40 individuals and collected seven including a juvenile (Hope, 1948). Lumsden (1957a) saw 12 birds at Neskamagige on July 14, 1957. A flock of 100 birds was seen near radar site 415 on July 14, 1964 (Lumsden, pers. comm.), the species was observed and collected near radar site 416 in August, 1968 (Young, pers. comm.), and observed in July, 1969 in the Brant River area (O'Reilly, 1969).

LESSER YELLOWLEGS. *Totanus flavipes.* At present the breeding status of this species as well as the Greater Yellowlegs (*Totanus melanoleucus*), in the Cape region, seems to be uncertain. At Cape Henrietta Maria, between July 20 and 24, 1947, flocks

FIGURE 5. Adult Dunlin (*Erolia alpina*) on nest near radar site 416, Cape Henrietta Maria region on June 28, 1970.

were seen totalling 150 birds (Manning, 1952). The 1948 R.O.M. field party collected three birds including two juveniles on August 3 (Hope, 1948). Lumsden (1957a) noted one at Neskamagige on July 14, 1957. The species was observed at radar site 415 on June 27, 1964 (Lumsden, pers. comm.), and we saw an agitated adult near radar site 416 also on June 27 in 1970.

KNOT. *Calidris canutus.* In the Cape region the Knot appears to be a coastal migrant only and has not been reported inland. A single juvenile was collected by the 1948 R.O.M. field party on August 14 (Hope, 1948).

PECTORAL SANDPIPER. *Erolia melanotos.* This species breeds south locally along the coast of Hudson and James Bays to Cape Henrietta Maria (Godfrey, 1966), and is at least an occasional breeder in the Cape region. Between July 20 and 24, 1947, at the Cape, Manning (1952) observed a total of 1,000 individuals in flocks along the flat shore, and in the grass marshes inland noted small groups of twos and threes or more. He collected a juvenile and five adults, one female of which had an incubation patch. Many Pectoral Sandpipers were seen and collected by the 1948 R.O.M. field party, including two half-grown birds on July 5. On this same date, in an area of grassy marshes and many sloughs, inland from the coast a few miles, they observed agitated adults (Hope, 1948). In July, 1957 at Neskamagige and Kawinabiskak, Lumsden (1957a) noted that the species was numerous, with some flocks of more than 50 birds being seen. The species was observed on June 27, 1964, at radar site 415 (Lumsden, pers. comm.), collected near radar site 416 in August, 1968 (Young, pers. comm.), and in July, 1969 was seen at radar site 415 and in the

Brant River area (O'Reilly, 1969). We did not observe this species in the area in 1970.

WHITE-RUMPED SANDPIPER. *Erolia fuscicollis.* This sandpiper has been observed in the Cape region only as a coastal migrant, although Manning (1952) suspected that a few pairs may breed on Cape Henrietta Maria. He based this suspicion on the well-marked incubation patches he noted on the two females he collected from the 65 birds seen at the Cape between July 20 and 24, 1947. Numbers of this species were seen and 11 birds, including two juveniles were collected by the 1948 R.O.M. field party on August 15, on the coast south of the Cape (Hope, 1948).

BAIRD'S SANDPIPER. *Erolia bairdii.* This is a coastal migrant in the Cape region. Two individuals were seen by T. M. Shortt of the 1948 R.O.M. field party on August 8 (Hope, 1948).

LEAST SANDPIPER. *Erolia minutilla.* This abundant migrant is a relatively common breeding bird in the Cape region. Manning (1952) noted that most of the 85 birds seen at the Cape between July 20 and 24, 1947, were nesting. On July 22 he collected two broods of newly-hatched, downy young. Many were seen and 15 collected (adults and juveniles) by the 1948 R.O.M. field party. On June 29 they found a nest with four eggs (Hope, 1948). This species was collected in August, 1968 near radar site 416 (Young, pers. comm.), and observed in July, 1969 at radar site 415 and the Brant River area (O'Reilly, 1969).

At radar site 416 in 1970 we noted that it was much less common than the Semipalmated Sandpiper (*Ereunetes pusillus*). We observed single individuals on June 28 and 29 and found and photographed a nest with the incubating adult and three eggs on July 2. This nest and the incubating adult were photographed.

DUNLIN. *Erolia alpina.* This very common migrant is probably also a common breeding bird in the Cape region. Between July 20 and 24, 1947, at the Cape, Manning (1952) observed 900 birds, of which five per cent were seen in the inland grass marshes and were probably nesting. He collected a brood of four downy young in the nest and the brooding male on July 21. In 1948 numbers were seen and collected, including juveniles, and on July 5 at an inland area of grassy marshes, a number of agitated adults which may have been nesting, were observed (Hope, 1948). This species was common at Neskamagige and Kawinabiskak in July, 1957 (Lumsden, 1957a), observed and collected in August, 1968 near radar site 416 (Young, pers. comm.), and seen in July, 1969 at radar site 415 and at the Brant River area (O'Reilly, 1969).

In 1970, in the immediate area near radar sites 415 and 416, we observed Dunlins daily from June 22 to July 1, both as territorial pairs and also in small flocks of up to several dozen birds. On June 27, two nests, each with four eggs, were found about two miles apart, both situated in wet, marshy areas of tundra (see Figure 5).

SHORT-BILLED DOWITCHER. *Limnodromus griseus.* The 1948 R.O.M. field party collected two juvenile dowitchers on August 14 (Hope, 1948). Many individuals of this species were seen on July 27, 1969 at the mouth of the Brant River (Lumsden, pers. comm.).

STILT SANDPIPER. *Micropalama himantopus.* Manning (1952) at the Cape saw five adults between July 20 and 23, 1947. He collected four adult males, two of which appeared to have nests or young. He also collected a half-fledged juvenile to establish the first Ontario breeding record. The 1948 R.O.M. field party saw numbers of this species, particularly in an area a few miles from the coast where they appeared to be breeding. They collected a total of 18, including two downy young on July 9 (Hope, 1948). One was observed on July 15, 1957 at Neskamagige (Lumsden, 1957a). In 1970 near radar sites 415 and 416 we noted small numbers, usually two or three pairs, on June 23, 27, 29, 30 and July 1. On the first four dates the birds were noted on wet, marshy tundra engaged in active courtship behaviour.

SEMIPALMATED SANDPIPER. *Ereunetes pusillus.* This is an abundant migrant and breeding bird in the Cape region. At Cape Henrietta Maria, Manning (1952) saw 400 birds in the period from July 20-24, 1947. He collected six, all with apparent incubation patches. Many individuals were seen by the 1948 R.O.M. field party, and a juvenile was collected on July 14 (Hope, 1948). Lumsden (1957a) noted small flocks along the Hudson Bay coast in the summer of 1957.

In the vicinity of radar sites 415 and 416, we observed this sandpiper daily from June 22 to July 4, 1970, usually as territorial pairs and occasionally in small, feeding flocks with other species. We found a total of five nests; one with three eggs on June 24, two nests each with four eggs on June 25, and two more nests each with four eggs on June 30.

MARBLED GODWIT. *Limosa fedoa.* T. M. Shortt of the 1948 R.O.M. field party saw six Marbled Godwits flying overhead on July 27 (Hope, 1948).

HUDSONIAN GODWIT. *Limosa haemastica.* This species apparently is a relatively common coastal migrant in the fall. The 1948 R.O.M. field party noted several hundred and collected 28 individuals in July and August. Four of the collected birds were juveniles (Hope, 1948). Between July 12 and 15, 1957 at Neskamagige and Kawinabiskak, Lumsden (1957a) noted 33 birds and collected two which had begun to moult. At the mouth of the Brant River in 1969, Lumsden (pers. comm.) observed one on July 14, 32 on July 15 and numbers on July 18. We observed a single bird exhibiting territorial behaviour on June 25 and 26, 1970, not far from radar site 415, and still another single bird on July 1 near radar site 416.

SANDERLING. *Crocethia alba.* The Sanderling seems to be at least at times an abundant autumn migrant in the Cape region. This species was observed and a total of eight were collected by the 1948 R.O.M. field party. They noted a flock of 1,000 birds on the coastal beach on July 18 (Hope, 1948). Young (pers. comm.) collected this species near radar site 416 in August, 1968.

NORTHERN PHALAROPE. *Lobipes lobatus.* This is a common, breeding shorebird in the wet marshes of the Cape region. At Cape Henrietta Maria, between July 20 and 24, 1947 there were 120 noted, most of which were males probably with nests or young (Manning, 1952). Many individuals on territory and in migrating flocks were seen and 25 were collected by the 1948 R.O.M. field party. They found a nest with four eggs on the point of hatching on July 1, and another nest with four eggs on July 21 (Hope, 1948). This species was collected near radar site 416 in August, 1968 (Young, pers. comm.), and was observed in July, 1969 both at radar site 415 and the Brant River area (O'Reilly, 1969).

We saw it daily from June 23 to July 4, 1970 in the vicinity of radar sites 415 and 416. We found three nests, each with four eggs, on June 26, 27, and 29, all of which were in wet, grassy areas. The June 27 nest was collected on July 4 and the eggs were found to be almost fully incubated.

PARASITIC JAEGER. *Stercorarius parasiticus.* This jaeger, reported by almost all field observers, is a characteristic breeding inhabitant and predator of the Cape region's tundra. On July 22, 1947, at the Cape, Manning (1952) collected two adults, as well as a downy young found dead near the nest, to establish the first Ontario breeding record. Several dozen sightings of this species were made by the 1948 R.O.M. field party, and nine birds were collected including a half-grown and still flightless young on July 23. They also found a nest that the young had recently vacated (Hope, 1948). In the summer of 1957 Lumsden (1957a) noted this species daily on the Hudson Bay coast usually as single birds or in twos, but occasionally in hunting groups of up to six. It was seen near radar site 416 in August, 1968 (Young, pers. comm.), and in July, 1969 at radar site 415 and at the Brant River area (O'Reilly, 1969).

We saw one or two near radar site 415 and 416 on seven different days in 1970. On June 25 we found a nest with two eggs belonging to two light phase jaegers. This nest and the two adults were photographed on June 26.

LONG-TAILED JAEGER. *Stercorarius longicaudus.* The 1948 R.O.M. field party saw single birds on July 2 and July 14, and collected the latter bird (Hope, 1948).

GLAUCOUS GULL. *Larus hyperboreus.* Single birds were seen by the 1948 R.O.M. field party on July 3 and August 17 (Hope, 1948).

ICELAND GULL. *Larus glaucoides.* The remains of an Iceland Gull were collected on August 17, 1968 about four miles east of radar site 416 (Young, pers. comm.).

GREAT BLACK-BACKED GULL. *Larus marinus.* An adult was seen on August 14 by the 1948 R.O.M. field party (Hope, 1948).

HERRING GULL. *Larus argentatus.* At Cape Henrietta Maria, Manning (1952) saw 14 and found two nests which probably had been robbed by Indians, between July 20 and 23, 1947. Herring Gulls were seen and four were collected by the 1948 R.O.M. field party (Hope, 1948). Lumsden (pers. comm.) has observed colonies a few miles north of radar site 416 and at the mouth of the Black Duck River. On July 22, 1957, Lumsden (1957a) noted a nest on a large boulder in (Lake) Kawinabiskak and about 20 on a lake at 55°3′N and 82°18′W. This species was collected near radar site 416 in August, 1968 (Young, pers. comm.), and was observed in July, 1969 at radar site 415 (O'Reilly, 1969).

We saw from one to several almost daily near radar site 416, from June 22 to July 4, 1970. A small colony of eight nests was found one mile west of radar site 416 on June 25, situated on a sedge "islet" just offshore in a circular lake one-third of a mile in diameter. This colony was revisited on June 29 at which time two of the nests were empty and the remaining six contained from one to three eggs.

SABINE'S GULL. *Xema sabini.* A single bird was collected by the 1948 R.O.M. field party, on the coast south of the Cape on July 19 (Hope, 1948).

ARCTIC TERN. *Sterna paradisaea.* Manning (1952) saw 14 terns which he presumed were this species, at the Cape between July 20-24, 1947. Over 100 Arctic Terns were observed and 25 collected by the 1948 R.O.M. field party. They found two nests each with two eggs on June 29, and collected still another set, one-third incubated, on July 1 (Hope, 1948). T. M. Shortt, one of the 1948 R.O.M. group members, collected an immature female on July 4 which was banded. It was later learned that this bird was banded as a nestling on July 22, 1947, at Grønne Ejland, Disko Bay, West Greenland, at about 69°N latitude. Lumsden (1957a) observed the species regularly along the Hudson Bay coast in 1957 and on July 12 saw empty nests on Manchuinagush Island. The species was collected near radar site 416 in August, 1968 (Young, pers. comm.). We saw two a mile west of radar site 416, at a Herring Gull (*Larus argentatus*) colony on June 25, 1970.

BLACK GUILLEMOT. *Cepphus grylle.* On July 19, 1947, Manning (1952) saw two about 15 miles south of the Cape. R. L. Peterson and L. Walden of the 1948 R.O.M. field party noted 50 guillemots and collected two on July 6, on the coast about ten miles south of Cape Henrietta Maria (Hope, 1948). The species was first established as an Ontario breeding bird by H. G. Lumsden on July 12, 1957. On that

date he collected two adults, a male and a female both with brood patches, from a flock of 80 birds disturbed from among the boulders at the northern tip of Manchuinagush Island. He also collected part of the shell of a hatched egg from among the rocks. Manchuinagush, part of the peninsula of Neskamagige, becomes an island at high tide, and is situated at the coast 22 miles west of the Cape at approximately 55°10′N and 82°39′W (Lumsden, 1959b, 1957a).

SNOWY OWL. *Nyctea scandiaca.* At Cape Henrietta Maria, Manning (1952) saw one on the marshes on July 20, 21 and 22, 1947, which he assumed was the same bird each time. Single birds were noted by the 1948 R.O.M. field party on July 2 and 3 (Hope, 1948), and by Lumsden (pers. comm.) near the Brant River on July 13, 1968. In 1971 single birds were also observed by Lumsden (pers. comm.) north of radar site 415 on July 29, and at Hook Point on October 16.

SHORT-EARED OWL. *Asio flammeus.* Although Manning (1952) acknowledges that this species is the common owl of the southern Hudson Bay and west James Bay coasts, he did not see one in the Cape region. At least a dozen individuals were seen and two collected by the R.O.M. field party in the summer of 1948. The strong possibility of breeding was suggested when they observed an agitated male in an area of tundra on August 6, although no young could be found (Hope, 1948). Lumsden (pers. comm.) noted one near Kawinabiskak on July 13, 1957. The species was observed near radar site 416 in August, 1968 (Young, pers. comm.), and we saw one flying slowly over the tundra in the same area on June 27, 1970.

COMMON NIGHTHAWK. *Chordeiles minor.* The only record of this species' occurrence in the Cape region is our observation of a single individual flying over radar site 416 on the evening of June 28, 1970. Its repeated call was tape-recorded on that occasion.

HORNED LARK. *Eremophila alpestris.* Manning (1952) suspected that the Horned Lark bred at the Cape. Between July 20 and 24, 1947, he noted 60 birds there and collected 11, four of which were flying juveniles. The 1948 R.O.M. field party saw several hundred larks during the summer, and collected 35 birds including some juveniles (Hope, 1948). On July 13, 1957, at Neskamagige, Lumsden (1957a) observed fledglings unable to fly. This species was collected near radar site 416 in August, 1968 (Young, pers. comm.), and seen in July, 1969 at radar site 415 and the Brant River area (O'Reilly, 1969).

We observed larks in the region daily from June 22 to July 4, 1970, usually as territorial pairs and occasionally in small feeding groups of several birds. We found a nest on June 24 containing three young in pin feathers and an infertile egg, and a second nest with four eggs on June 28. Both nests were on dry tundra areas between radar sites 415 and 416.

TREE SWALLOW. *Iridoprocne bicolor.* The R.O.M. field party of 1948 noted single Tree Swallows on August 9 and 16, and two birds on August 17 (Hope, 1948). One was seen at Neskamagige on July 16, 1957 (Lumsden, pers. comm.). The species was observed nesting in a pipe at radar site 415, on June 28, 1964 (Lumsden, pers. comm.). In 1970, on six different days (June 23, 27, 28, 29, July 1 and 3), we noted from one to four which appeared at the cabin at radar site 416. They perched and flew around for varying lengths of time, and then would disappear as suddenly as they had come.

BARN SWALLOW. *Hirundo rustica.* Lumsden (pers. comm.) noted this species flying into a shed at radar site 415 on June 28, 1964, and at this same location on June 24, 1970, we observed what appeared to be an old Barn Swallow nest on a beam, at a height of 15 feet in a shed.

COMMON RAVEN. *Corvus corax.* The relative scarcity of the raven in the Cape region prior to the erection of the radar stations in the 1950's, would appear to be due to a paucity of suitable nesting sites. Manning (1952) did not observe any in the area in July, 1947, and only a half-dozen were seen by the R.O.M. field party in the summer of 1948 (Hope, 1948). In 1964, at radar site 415, a nest with four young was found by H. G. Lumsden, situated on one of the large, fixed radar screens (O.N.R.S.). This species was observed near radar site 416 in August, 1968 (Young, pers. comm.), and again found nesting on the radar screens at site 415 in July 1969 by O'Reilly (1969) who noted the species later in July in the Brant River area.

In the summer of 1970, at radar site 416, a pair of Common Ravens had a nest with three large young on a cable tower support, attached to the cabin. We found this nest on June 22 as we set up camp, and by June 24 the adults had deserted and the young were dead in the nest. We saw single birds or pairs on nine different days in the general vicinity, and on June 24 we examined four old, empty nests on the radar screens at site 415.

BOREAL CHICKADEE. *Parus hudsonicus.* This species was observed near radar site 416 on July 14, 1964 (Lumsden, pers. comm.).

ROBIN. *Turdus migratorius.* On July 8, 1948 the R.O.M. field party found the skull of a Robin near the coast, south of the Cape (Hope, 1948). The species was seen at radar site 415 on June 28, 1964 (Lumsden, pers. comm.). A single bird was seen and heard by us near radar site 416 on June 25, 26, 27, July 1 and 3, 1970. This bird frequented the dense willow border of a tundra pool near the cabin, but was furtive and difficult to approach.

WATER PIPIT. *Anthus spinoletta.* Although Manning (1952) did not observe this species in the Cape region in July, 1947, it would appear to be a relatively common summer resident and breeding bird. L. Walden of the 1948 R.O.M. field party established the first provincial breeding record for this species on June 29,

when he found a nest and six eggs. Later five nestlings from this nest were collected at various stages of development. Other juveniles and some adults were also seen and collected (Hope, 1948). The species was collected near radar site 416 in August, 1968 (Young, pers. comm.), and was seen at radar site 415 and in the Brant River area in July, 1969 by O'Reilly (1969). Lumsden (pers. comm.) observed an adult carrying food at radar site 415 in July, 1969, and on July 22 of that year he saw young pipits just able to fly, near the mouth of the Brant River and also noted two pairs carrying food. Near radar site 416 we saw one or occasionally two birds on June 23, 25, 26, 27, July 1, 2 and 4, 1970, at least some of which we assumed were on territory, although no nests were found.

NORTHERN SHRIKE. *Lanius excubitor.* A mummified body of one was found at a fox den near the mouth of the Brant River on July 17, 1969 (Lumsden, pers. comm.).

STARLING. *Sturnus vulgaris.* Lumsden (pers. comm.) observed two at radar site 415 on June 28, 1964. Later, on July 13 at this same location he saw five and assumed that a nesting had taken place.

YELLOW WARBLER. *Dendroica petechia.* According to Manning (1952) this species is a common summer resident along the southern Hudson Bay and west James Bay coasts, although he failed to note it in the Cape region in July, 1947. The species was observed at radar site 415 and at the Brant River area in July, 1969 by O'Reilly (1969). We observed two near radar site 416 on June 27, 1970, and thereafter heard or saw single birds on June 28, 29, July 2 and 3. Invariably these birds were in the dense willow borders of nearby tundra sloughs.

RED-WINGED BLACKBIRD. *Agelaius phoeniceus.* A single male was collected by T. M. Shortt of the 1948 R.O.M. field party on July 20 (Hope, 1948). Two adult females were seen at radar site 415 on June 28, 1964 (Lumsden, pers. comm.).

PURPLE FINCH. *Carpodacus purpureus.* One was collected at radar site 416 in August, 1968 (Young, pers. comm.).

COMMON REDPOLL. *Acanthis flammea.* The 1948 R.O.M. field party found a nest of this species with four young, in dwarf willows, on July 20, and collected two juveniles near by on August 3. They saw also a number of adults, 11 of which they collected (Hope, 1948). H. G. Lumsden found a nest with four eggs at radar site 415 on June 16, 1965 (O.N.R.S.). The species was observed in the Brant River area in July, 1969 (O'Reilly, 1969). We saw from one to several near radar site 416 on June 23, 24, 26, 27, and 29, 1970, but observed no evidence of nesting.

WHITE-WINGED CROSSBILL. *Loxia leucoptera.* A single female of this species was closely observed by C. E. Hope of the 1948 R.O.M. field party on July 8 (Hope, 1948). Lumsden (pers. comm.) saw two juveniles in the willows at the Brant River on July 28, 1969.

SAVANNAH SPARROW. *Passerculus sandwichensis.* Manning (1952) reported this sparrow to be the most numerous bird along the coasts of Hudson and James Bays from York Factory to Moose River, in the summer of 1947. At Cape Henrietta Maria he noted 60 birds between July 21 and 24. Lumsden (pers. comm.) also feels that this species is probably the commonest bird in the Cape region. The R.O.M. field party observed several hundred birds, from singles and breeding pairs, to flocks of up to 150 individuals, in the summer of 1948. They collected several dozen birds including a juvenile, and also found two nests, each with five eggs on July 7 and 9 (Hope, 1948). Savannah Sparrows were collected near radar site 416 in August, 1968 (Young, pers. comm.), and observed in July, 1969 at radar site 415 and the Brant River area (O'Reilly, 1969). H. G. Lumsden found a nest with five young near the mouth of the Brant River on July 17, 1969, and two nests in the same general area on July 14 and 17, 1970, each containing four young (O.N.R.S.).

We observed Savannah Sparrows almost daily from June 22 to July 4, 1970, usually in pairs or small flocks in the vicinity of radar site 416, and also found two nests, each with four eggs, on June 29 and 30.

SHARP-TAILED SPARROW. *Ammospiza caudacuta.* Godfrey (1966) states that this species breeds in northern Ontario along the coast of James Bay north to Cape Henrietta Maria. Two male birds were collected by T. M. Shortt of the 1948 R.O.M. field party, one on July 8 and the other on July 21. They also observed this sparrow on July 2 and 19 (Hope, 1948).

TREE SPARROW. *Spizella arborea.* This species undoubtedly breeds in the Cape region, in suitable areas of dwarf birch and willow, and Godfrey (1966) refers to it breeding in northern Ontario at Cape Henrietta Maria. Although Manning (1952) did not observe Tree Sparrows in the Cape region in 1947, the 1948 R.O.M. field party collected 14 of which six were flying juveniles (Hope, 1948). A female was collected by H. G. Lumsden at radar site 415 on July 13, 1964 and its skeleton is in the R.O.M. collection. This species was collected near radar site 416 in August, 1968 (Young, pers. comm.), and we observed a few individuals there in stands of arctic willow on seven different days from June 22-July 3, 1970.

FIELD SPARROW. *Spizella pusilla.* Lumsden (pers comm.) observed it in the Cape region at the forks of the Brant River on July 20, 1969.

WHITE-CROWNED SPARROW. *Zonotrichia leucophrys.* This sparrow was collected near radar site 416 in August, 1968 (Young, pers. comm.), and observed in July, 1969 at radar site 415 (O'Reilly, 1969).

The first observations of its nesting in the Cape region would appear to be of the two nests, each with four eggs, that we found on June 29 and 30, 1970 near radar site 416.

LAPLAND LONGSPUR. *Calcarius lapponicus.* This is an abundant, breeding summer resident of the Cape region. The first breeding record for Ontario was made by T. H. Manning (1952) who found a nest with eggs and also collected a juvenile not quite able to fly, at Cape Henrietta Maria, between July 20 and 24, 1970. He observed a total of 41 in this area. Large numbers were seen and collected by the 1948 R.O.M. field party, and a nest containing three young was found on July 2 (Hope, 1948). H. G. Lumsden (1957a) noted male birds at Neskamagige and Kawinabiskak in the summer of 1957, and he found a nest with three young at radar site 415 on July 13, 1964 (O.N.R.S.). The species was collected near radar site 416 in August, 1968 (Young, pers. comm.), and observed in July, 1969 at radar site 415 and in the Brant River area (O'Reilly, 1969).

We noted Lapland Longspurs daily near radar site 416 between June 22 and July 4, 1970. Breeding pairs in this area were evenly distributed on the tundra and were almost never out of our sight or hearing. A nest with four eggs, well-concealed in a small tundra depression, was photographed on June 29 and both adults were photographed there on June 30.

SMITH'S LONGSPUR. *Calcarius pictus.* Although Manning (1952) collected a juvenile of this species in 1947 at Little Cape, west of the Cape region, and presumed that they were nesting there, he did not observe any in the study area. Over 100 individuals were seen and 27 collected by the R.O.M. field party, in the summer of 1948 They also found a nest with four eggs on June 29 and another nest containing five eggs on the point of hatching on July 7 (Hope, 1948). T. M. Shortt (pers. comm.), with the 1948 R.O.M. group, observed that no Smith's Longspurs were to be seen migrating south down the west coast of James Bay at the time when many Lapland Longspurs (*Calcarius lapponicus*) were drifting down through that region.

Despite the fact that we observed Smith's Longspurs almost daily near radar site 416 they were noticeably less abundant than the Lapland Longspurs and appeared to favour wetter areas of the tundra. After a lengthy search a female was flushed from a nest with four eggs on June 30, 1970, and both the nest and female were photographed on July 1.

SNOW BUNTING. *Plectrophenax nivalis.* Manning (1952) states that Snow Buntings are occasionally seen along the Hudson and James Bay coasts in the summer, as non-breeding individuals. He relates an observation of a bird seen by D. MacKenzie at Cape Henrietta Maria, about July 20, 1947. Young (pers. comm.) collected the remains of a Snow Bunting near radar site 416 in August, 1968. We saw single individuals near radar site 416 on June 23, 26, and July 3, 1970, and collected the remains of another on June 25. Lumsden (pers. comm.) observed a small flock at the forks of the Brant River on June 26, 1971.

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Winter Habitat Preference of Porcupines in the Southern Alberta Foothills

Don Gill[1] and Lawrence D. Cordes[2]

[1]Department of Geography, University of Alberta, Edmonton, Alberta
[2]Department of Geography, University of Calgary, Calgary, Alberta

Abstract. Isolated stands of limber pine (*Pinus flexilis*) that occur on windswept ridge crests in the southern Alberta foothills create islands of winter habitat for porcupines (*Erethizon dorsatum*). The dwarfed and stunted growth-form of this tree provides cover, while the high nutrient content of its bark makes it a preferred source of winter food. Reduction in predators during the past half-century has apparently enabled porcupine numbers to increase to the point where they are now threatening the existence of limber pine. These trees occur as an unusual low-elevation krummholz, and may thus have value to man as an aesthetic resource; if these limber pine stands are to survive, control of porcupine numbers may have to be initiated.

Introduction

Most of the fescue grassland prairie in the foothills region of southern Alberta has been modified by ranching and farming activities, and little of the original vegetation remains. Along ridge crests and valley bottoms in the western foothills are islands of relatively undisturbed vegetation, however, that provide habitat for a variety of animals. The purpose of this paper is to describe how one animal, the porcupine, utilizes these islands of habitat during winter. Of greatest interest is the winter feeding activity of this species in its almost exclusive use of the bark of limber pine where it occurs as a krummholz growth-form on exposed ridges.

Study area: Methods

This study was conducted in southwestern Alberta (Figure 1) during the winters of 1970-71 and 1971-72. Food habits and movements of porcupines were determined by tracking animals during 27 days from November through March of both winters; this was done during periods when fresh snow made it possible to monitor movements. Food preference was also determined by this method; most feeding activity takes place on the ground where pruned foliage is readily observed. Samples of bark

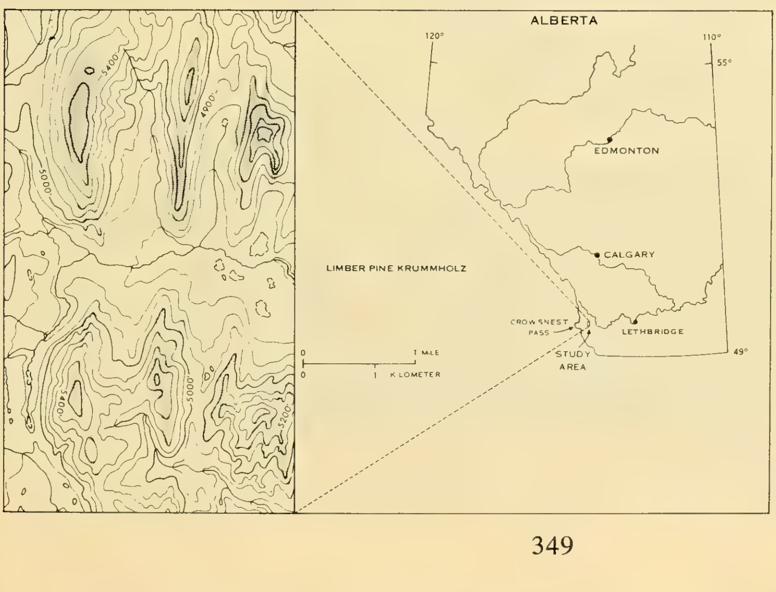

Figure 1. Distribution of limber pine krummholz stands on ridges in the study area of the southern Alberta foothills.

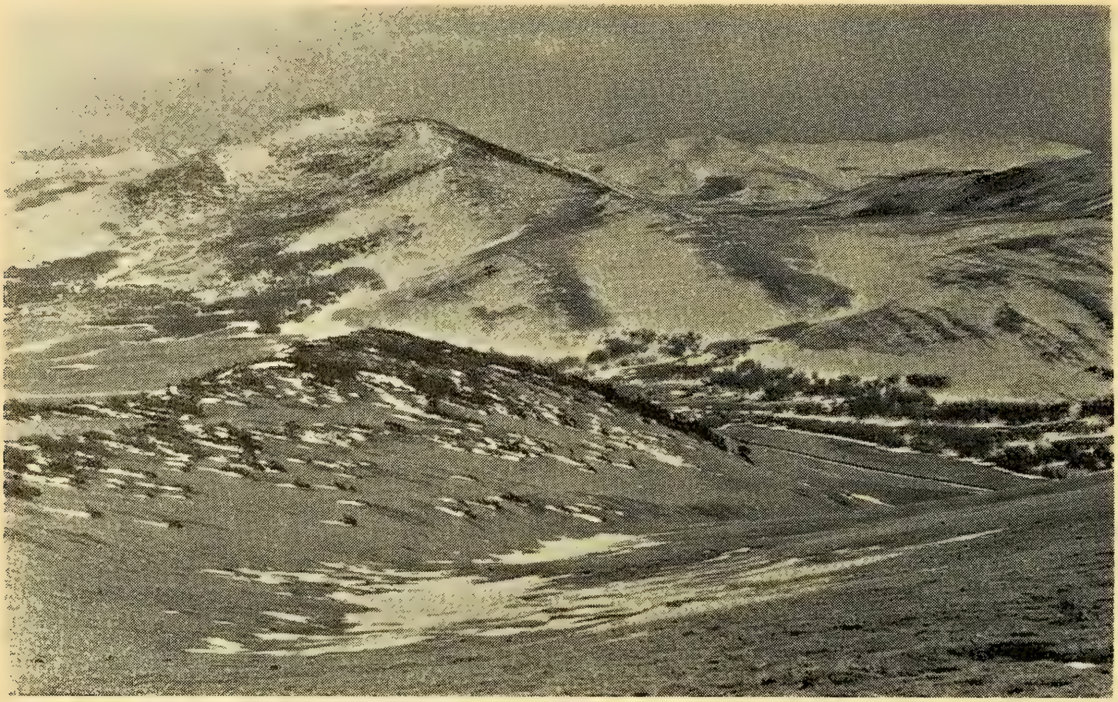

FIGURE 2. Fescue prairie and woodland in the foothills of southern Alberta; the dark-toned vegetation along ridge crests is limber pine krummholz. Stands of aspen, willow, and water birch occur in sheltered valleys (right center).

were taken for analysis of moisture, protein, fat, fiber, calcium, phosphorus, and nitrate contents by the Agricultural Soil and Feed Testing Laboratory, Edmonton, Alberta, using the methods of the Association of Official Agricultural Chemists (1955), as modified by this Laboratory.

Results and Discussion

The grasslands of the foothills region of Southern Alberta do not in general constitute good habitat for porcupines (Soper, 1964); according to Taylor (1935), this animal ranges "with certain outstanding exceptions" throughout the forested area of North America mainly in the "Hudsonian, Canadian and Transition zones." In southern Alberta Soper (1964) states that porcupines prefer the more highly elevated montane woodlands than the lower terrain of the mountain valleys and foothills to the east. Forests, therefore, constitute the main habitat of this generally arborescent animal. Trees (*Populus* spp.) exist in the study area but only in narrow scattered ribbons along stream bottoms (Figure 2). Shrubs (*Salix* spp. and *Betula occidentalis*) that occur in sheltered locations are low growing and provide little cover. Porcupines nevertheless may reach a relatively high density in certain areas of the foothills. From counts of individual tracks, scat densities and sightings, we estimate that the study area (Figure 1) supported a minimum of 12 animals per square km during the period of investigation. This population was very unevenly distributed reflecting the availability of an unusual food source and cover in the form of limber pine krummholz.

Low-elevation Krummholz

The study site is within the area of Alberta that receives the greatest frequency of winter chinook winds (Longley, 1967), due in large

part to the proximity of the Crowsnest Pass (Figure 1), one of the major wind gaps of the Rocky Mountains. During winter, winds often exceed 100 km/hr in exposed locations, which, associated with raised temperatures (usually above freezing), may cause winter-kill of perennial vegetation. The topography of the study area consists of alternating thrust-fault ridges and valleys (Figure 1) and the ridge tops receive the greatest exposure. The only locally-occurring tree species that is able to tolerate this exposure is the limber pine which forms discrete stands on virtually every ridge. Most trees are "dwarfed and distorted" (Moss, 1955) and grow with their boles touching the ground (Figure 3), to form well-developed krummholz at 1500-1700 m (4900-5600 feet; Figure 1).

Use of Limber Pine by Porcupines

The feeding habits of porcupines vary regionally, depending on the availability of preferred foods, and coniferous trees figure largely in their diet wherever it is available (Curtis, 1944; Marshall *et al.,* 1962; Soper, 1964; Cowan and Guiguet, 1965). In the study area, the prostrate pine krummholz affords a preferred and easily-obtained winter food (Figure 4). The food preference of more than fifty tracked animals was determined, and in only three instances (where some willow bark was utilized) was it found that porcupines on the study site used anything but limber pine. The trees are very heavily barked on some ridges which has caused numerous individuals to die. The almost exclusive use of limber pine is due at least in part to its availability and the ease at which it may be obtained. It is the only conifer in the study area and there is little other vegetation available for use as winter food. A more significant reason for its abundant use may be the high food value of limber pine. Table 1 shows the average composition of twenty samples of the bark of this species collected January, 1970.

FIGURE 3. Dwarfed, distorted limber pine tree, 120 years old and 3.9m in length, growing with its bole on the ground to form well-developed krummholz. Most ridge crests are made up of exposed sandstone as shown here. Altimeter near base of trunk provides scale.

TABLE 1. — Nutritive value of the bark of coniferous trees occurring in the Alberta Foothills

Species	Percent Moisture	Percent crude protein		Percent crude fat	Percentage basis air-dry weight of sample			
		Air-dry basis	Moisture-free basis		Fiber	Calcium	Phos-phorus	Nitrate as KNO^3
Limber Pine	56.3	1.9	3.2	12.7	9.7	.70	.04	Nil
White Spruce	44.0	1.7	3.0	2.0	21.3	.87	.07	Nil
Douglas-Fir	44.4	1.6	2.9	3.1	11.8	.22	.04	Nil
Lodgepole Pine	41.9	1.1	1.9	7.7	24.3	.49	.02	Nil

Three other southern Alberta conifers were also collected at this time to compare food values; these species (white spruce (*Picea glauca*), Douglas-fir (*Pseudotsuga menziesii*) *and lodge*pole pine (*pinus contorta*)) do not occur in the study area although they are prevalent some 10 km to the west and 15 km eastward.

Table 1 illustrates that the moisture content of limber pine bark ranges from 12-14 percent higher than the other conifers. The percentage of air-dry crude protein is only somewhat higher than the other species, but when measured on a moisture-free basis, its value is considerably greater than lodgepole pine (3.2 compared to 1.9 percent) and somewhat higher than white spruce or Douglas-fir. The average fiber value of limber pine is significantly lower than that of white spruce or lodgepole pine; it is marginally lower than Douglas-fir. A low crude fiber content indicates a low degree of lignification and thus a high amount of available energy (Scotter, 1972), which places limber pine in a

FIGURE 4. Bark of prostrate limber pine krummholz provides an easily-obtained and preferred winter foor source. Note the different-aged usage of the bark by porcupines, as seen in the tonal differences of the exposed wood.

superior position as a food species, particularly when compared with white spruce or lodgepole pine.

An important energy source for any animal is crude fat. The bark of limber pine contains high fat levels during winter when the maintenance of energy may be critical. When compared to the other conifers, it is seen that limber pine has more than six times as much crude fat as white spruce, four times as much as Douglas-fir, and nearly twice as great a content as lodgepole pine. This clearly adds to the food value of limber pine, particularly as a winter source. Calcium and phosphorus levels are inconclusive, with limber pine showing an intermediate value with the other conifers (Table 1). It does appear that limber pine, at 0.7 percent, contains an amount of calcium that is well within the range of requirements of certain mammals (Scotter, 1972), although the calcium requirements of porcupines are not known.

The preferred nature of limber pine as a food source for porcupine is also seen in the Porcupine Hills,[1] 15 km to the east of the study area. These hills are covered by dense stands of aspen, Douglas-fir, lodgepole pine and white spruce; limber pine is also present, but nearly always occurs in pure stands. During the summer of 1970, three graduate students of the second author spent four months in the Hills studying forest types other than limber pine, and observed no porcupines in these stands. During the summer of 1971, however, a fourth student studied limber pine stands and made more than seventy individual sightings within an area of 8 km^2 of limber pine (Shouesmith, personal communication). This compares favourably with the population density estimated in the present study area.

As recorded by Hayward (1952), krummholz also creates an important protective cover and is thus utilized by many animals. This was found to be true of porcupine use in the study area; after feeding on the bark of limber pine, porcupines often moved only a few tens of meters (Figure 5) to a convenient shelter under the dense, low-flung branches. Porcupines also moved downslope to an adjacent valley bottom to take cover in willow or water birch thickets.

Influence of Man on Porcupine Density

By reducing predator populations in the southern Alberta foothills, European settlement has undoubtedly affected the numbers of porcupines. Prior to the turn of the century, such animals as the fisher (*Martes pennanti*) and the mountain lion (*Felis concolor*), which are successful predators of the porcupine (Soper, 1964; Trippensee, 1953) were in greater abundance in the foothills. Indiscriminate poisoning during the past several decades has reduced the numbers of coyotes (*Canis latrans*), another predator of the porcupine (at least of young animals). Indians who inhabited this area had "a pronounced fondness of porcupine meat" (Soper, 1964), and they undoubtedly helped to keep this easily-hunted animal in check. Indians today are settled on reservations 25 km from the study area and engage in much less hunting than previously.

Taken together, these reasons may explain why the porcupine has experienced an apparent increase in southern Alberta during the past half century. By interviewing long-established ranchers, we ascertained that during the early 1900's very few porcupines were seen on the foothills ranches. Numbers have slowly increased until a high in the population appears to exist now. It is impossible to state with certainty that predator control and reduced hunting pressure have enabled this apparent increase, but it is reasonable to assume so. This supposition is somewhat corroborated by field evidence; although the krummholz pine in question range in age up to 210 years, they show evidence of only recent use by porcupines, probably within the past three decades. It is impossible to determine the length of this use with certainty, but it is clear that the presently extensive pruning cannot have existed very long; if it had, much of the limber pine would be dead through over-use. Many individuals have already been killed, and it is evident that if such use had occurred over a long

[1]These hills were so named by the Indians because seen at a distance they resemble a porcupine's back.

FIGURE 5. Porcupines in the study area often use the low-flung branches of limber pine for protection; this individual had finished feeding and was enroute to cover formed by the mat of krummholz seen on the left (January, 1970).

period of time, these stands would no longer be present.

The maintenance of low predator populations in the southern Alberta foothills (by increasing settlement and predator control) may ensure that high porcupine densities will remain in the study region. Stands of limber pine krummholz represent a considerable aesthetic resource here (Cordes and Gill, 1972) and this vegetation is in danger of being eliminated.

Conclusion

This study has shown that isolated stands of limber pine krummholz form significant winter habitat for local porcupine populations in the southern Alberta foothills. Analysis of bark illustrates that limber pine has a higher nutrient content than other conifers in this area, which appears to make it a preferred winter food source. Its palatability and ease of pruning may eventually cause it to be eliminated by porcupines, particularly if low predator numbers are maintained. If it is deemed that these low-elevation krummholz stands are valuable as an aesthetic resource, control of porcupine numbers may have to be initiated to assure that these stands will survive.

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Sapsucker Nest Holes and Their Use by Other Species

A. J. Erskine[1] and W. D. McLaren[2]

Abstract. This paper presents additional evidence that Yellow-bellied Sapsuckers commonly nest in aspen trees in early stages of heart rot. In southern parts of their range, where aspens are less common, they also use a wide variety of broad-leafed trees. The selective advantage of the easily excavated interior surrounded by a sound, protective shell of living wood is not obvious in central British Columbia and elsewhere in the northern forests, where potential predators are scarce. Competition from Starlings is at present greatly reduced by the ready availability of flicker holes. The large, northern flying squirrel is unable to use sapsucker holes, and use by flying squirrels is confined to the small, southern species.

Introduction

Two recent papers (Kilham, 1971; Dennis, 1971) presented data on the nest sites of sapsuckers and similar-sized woodpeckers and on use of these cavities by other animals. Our records presented in this paper differ in some respects from their findings, and we discuss possible causes for these differences.

Kilham (1971) discussed nest holes of the Yellow-bellied Sapsucker *Sphyrapicus varius* in New Hampshire, with particular attention to their preference for aspens *Populus tremuloides* infected with *Fomes* rot, to predation of such nests by raccoons *Procyon lotor,* and to interrelations with squirrels, especially flying squirrels *Glaucomys* spp. Dennis (1971) studied nest holes of the similar-sized Red-cockaded Woodpeckers *Dendrocopos borealis* in South Carolina, including their subsequent use by flying squirrels and, after enlargement by Pileated Woodpeckers *Dryocopus pileatus,* gray squirrels *Sciurus carolinensis.* He also speculated on the role of pine gum around nest holes of this species in reducing predation by tree-climbing snakes.

We studied sapsucker nests in the Cariboo Parklands of British Columbia (Munro, 1945) in 1958-59, as part of our work on hole nesting birds (Erskine, 1960; McLaren, 1963). Sapsuckers were common breeding birds in the aspen groveland, where in summer we often heard young sapsuckers calling simultaneously from two or three different nests. Erskine also observed a number of other sapsucker nests during studies in north-central Alberta in 1964 (Erskine, 1968) and New Brunswick in 1968-69. We have also examined all sapsucker nest records in the Maritimes (MNR), Quebec (QNR), Ontario (ONR), Prairie (PNR), and British Columbia (BCNR) nest records schemes.

Nest Sites

In 1958-59, we examined 40 to 50 active sapsucker nests together with many more left from previous years. As noted by many authors (cited in Bent, 1939), a tree with an active sapsucker nest often had several other holes made by the same species in earlier years. In the Cariboo, these trees were (almost) without exception aspens, as no other deciduous trees of suitable size were common in the areas worked. Sapsucker nests examined in Alberta and New Brunswick were also usually in live aspens.

The nest records (Table 1), however, showed that this was not as general as our data and those of Kilham (1971) and Lawrence (1967) suggest. In fact, three samples of 23 to 32 nests (Nova Scotia, Quebec, and B.C. coast) had less than 10 per cent in aspens. Our records are included in the totals for the various provinces.

Our measurements of nest sites of sapsuckers in the Cariboo showed that the sills of these cavities averaged nearly two inches (5.1 cm) in thickness, whereas sills of nests made by flickers *Colaptes* were much thinner (Table 2). Virtually all aspens there of diameter greater than 8 inches (20 cm) were rotted in the heart

[1]Canadian Wildlife Service, Ottawa, Ontario.
[2]1832 Myrtle Way, Port Coquitlam, British Columbia.

TABLE 1. — Trees used for nesting by Yellow-bellied Sapsuckers, based on Canadian nest record cards.

Genus	Number of trees of genus used in										
	N.S.	N.B.		Que.	Ontario			Prairie Provinces	B.C.		
		Gibbon	other		N of 46°	Law-rence	S of 46°		NI *	SI *	Coast *†
No. nests in sample	32	44	38	23	31	32	99	51	85	80	30
Tree Unspecified	2	0	2	5	4	0	4	3	0	6	6
Populus (poplars, esp. aspens)	2	11	22	0	20	32	34	46	84	31	3
Betula (birches)	18	12	8	3	6	0	12	0	0	14	1
Acer (maples)	8	19	3	4	0	0	23	0	0	0	9
Other broad-leafed trees‡	1	2	2	8	0	0	23	1	0	13	3
Pinus (pines)	0	0	0	0	0	0	1	0	0	8	0
Pseudotsuga (Douglas fir)	0	0	0	0	0	0	0	0	0	4	4
Other coniferous trees #	1	0	1	2	1	0	2	1	1	4	4

*NI – Interior B.C. north of 51°; SI – Interior B.C. south of 51°; Coast – west of Coast/ Cascades Mts.
†Including data from Kelleher (1963).
‡*Ulmus* (elms), *Fagus* (beech), *Alnus* (alders), *Fraxinus* (ashes), *Juglans* (butternut), *Quercus* (oaks), *Salix* (willows), *Tilia* (basswood), *Prunus* (cherries), *Ostrya* (ironwood).
#*Picea* (spruces), *Tsuga* (hemlocks), *Larix* (larches).

wood, and most trees of this size contained one or more woodpecker holes. Sapsuckers were evidently prepared to cut through a greater thickness of sound wood in order to reach the rotted core than were flickers, the only other common woodpeckers in the groveland, and were thus the first species to excavate in a tree that was starting to rot. Twice we noted holes made by sapsuckers in 1958 that were taken over and enlarged by flickers in 1959. The flicker cavities were typically much larger as well as having thinner sills than those of sapsuckers (Table 2).

Use by Other Vertebrates

In marked contrast to flicker holes, which were used by many other species (McLaren, 1963), sapsucker holes in the Cariboo often remained empty in succeeding years. Typical "sapsucker tenement" trees contained up to five or even more holes, but until these rotted out or were enlarged the only other occupants were Tree Swallows *Iridoprocne bicolor,* and occasionally chickadees *Parus atricapillus* and *P. gambeli* or Red-breasted Nuthatches *Sitta canadensis*. The three latter species more commonly excavated their own holes in the thick but rather soft bark of Douglas firs *Pseudotsuga menziesii*. We never found a flying squirrel occupying a sapsucker hole in the Cariboo, although we found several squirrel nests each year in flicker cavities. Likewise, the vast majority of nests of Starlings *Sturnus vulgaris* and Mountain Bluebirds *Sialia currucoides* were in flicker holes. We saw no instances of predation on nests in sapsucker holes, and very few even on nests in larger cavities.

Discussion

The use by sapsuckers of aspens is related to the availability of these trees as well as to their relatively soft wood and susceptibility to

Table 2. — Measurements and situations of nest sites used by sapsuckers, flickers, and flying squirrels in the Cariboo district, B.C. (all measurements in inches unless otherwise specified).

	Measurement of holes used by		
	Sapsuckers* (14 measured)	Flickers† (300+ measured)	Flying squirrels (6 measured)
Entrance size	1½ × 1⅝	2½ × 2¾	3 × 3
Sill thickness	1⅞	¾	1
Cavity diameter	4¾	6	7
Cavity depth	6½	12	12
Entrance height (from ground)	4½–32½′ (most 10–20′)	3–50′ (most 10–20′)	6½–31′
Tree diameter at nest height	9	10 in aspens 20 in D.Firs	10 in aspens 20 in D. Firs
Tree condition	nearly all alive	trees and stubs, alive and dead	all in stubs

*Based on our own unpublished notes – except nest height from a sample of 60 nests in Cariboo/Chilcotin area (BCNR).
†Based upon McLaren (1963).

heart rot. In much of the boreal forest of Canada, aspens are, with balsam poplars *P. balsamifera* and paper birches *Betula papyrifera,* the only common broad-leafed trees of any size (Rowe, 1959). Aspens become less common and largely confined to early successional stages as one moves south in the eastern deciduous forest. There are no really satisfactory data on sapsucker densities in different areas, but they too are most generally distributed in the boreal forests and become scarcer and more local farther south. The roadside breeding bird surveys (Robbins and Van Velzen, 1969; Erskine, 1972 and unpublished) do not extend far enough into the boreal forest to give a representative picture. The highest densities reported, except on two surveys in British Columbia, were in central New Brunswick and between Georgian Bay and the Laurentian uplands in Ontario and Quebec, both areas having severe infestations of spruce budworm. The forests there are transitional between the boreal and eastern deciduous types, with aspens common but not usually the commonest broad-leafed tree. The nest records from Nova Scotia, Quebec and southern Ontario were from still farther south, in largely deciduous forest, and most nests there were in trees other than aspens. Kilham (1971) also noted that 21 of the 50 nests he examined were in other species of tree, although he believed that these were less favourable sites.

Most sapsucker nests in aspens are well protected except from predators slender enough to enter the cavity or powerful enough to break or chew open the tree. In the Cariboo, as in most of the northern forests, arboreal snakes are lacking, as are raccoons, which are major predators of hole nesting birds elsewhere in North America. We saw a few nests that had been destroyed by weasels *Mustela erminea,* and were told of others torn open by bears *Ursus americanus* (L. Sugden, letters of July 1960 and June 1961), but these were all in flicker holes. One sapsucker nest near Merritt, B.C., was clawed by a bear, which failed to break it open; the young later fledged (M. Egely, BCNR). In contrast, among 16 sapsucker nests followed up by Gibbon (1970, and MNR; not including those whose outcome was affected by experimental manipulation) in central New Brunswick, six failed, and two others lost some young to predation. This was in a recently logged area where all nests were in rotten stubs of maple or birch. Red squirrels *Tamiasciurus hudsonicus* were judged responsible for most predation, although a bear tore down one stub and another fell from natural

causes (probably wind). If sapsuckers evolved selection of well-protected nest sites in live aspens in response to predation pressure, this must have taken place in areas where predators were numerous and where a wide choice of nest sites was available. Alternatively they could have evolved in the boreal forest, with aspens as the most readily available nest tree (among broad-leafed species), and the situation described by Kilham (1971) may be representative only of the southern edge of the range.

The scarcity of competitors for sapsucker holes is also surprising, since these sites were available in numbers only exceeded (in the Cariboo) by those of flickers. Kilham (1971) suggested that sapsuckers avoided competition with Starlings by nesting within woods. In the Cariboo also, Starlings were absent from closed stands, but such were usually of Douglas fir or lodgepole pine *Pinus contorta,* neither of which attracted sapsuckers, although flickers nested in fir stubs. The aspen habitat favoured by both Starlings and sapsuckers was so open that even in the heart of a grove one was seldom out of sight of grassland, either open range or a strip bordering a lake or slough. Starlings only occupied the Cariboo district during the decade before our studies (Myres, 1958), and reached a saturation level about 1958. The ready availability of flicker holes may have reduced the need for Starlings to use the smaller sapsucker holes. When a new equilibrium, probably involving fewer flicker holes, is reached between Starlings and their woodpecker hosts, pressure on sapsucker nest sites may increase (McLaren, 1963).

We believe that the squirrels in the Cariboo are too large to use sapsucker holes (Table 2). Only the larger species of flying squirrel, *Glaucomys sabrinus,* in one of its larger races, is present in this area (Cowan and Guiguet, 1956). Dennis (1971) did not state the species of flying squirrel using Red-cockaded Woodpecker holes, but in South Carolina it could only be the smaller species, *G. volans* (Hall and Kelson, 1959). Kilham (1971) remarked that both species of flying squirrels occur in New Hampshire, but that he was unable to distinguish them under field conditions. We believe that the ones found in sapsucker holes were also *G. volans,* a much smaller animal than *G. sabrinus,* whose western races are nearly as large as a red squirrel (Table 3). The only flying squirrel Erskine saw in over 10 years in the Maritime Provinces, where only *G. sabrinus* occurs, was flushed from a flicker hole.

TABLE 3. — Comparative measurements of some tree squirrels.

Species (No. measured)	Weight Range (gm)	Mean Body length (mm)
Glaucomys volans		
(12 from N.Y.) 1/	45–70	126
G. sabrinus		
(from Mich.) 2/	74–125	
(16 from Alta.) 3/	142–199	182
Tamiasciurus hudsonicus		
(28 from N.Y.) 1/	140–220	190
(116 from Alta.) 3/	173–312	193
Sciurus carolinensis		
(10 from Fla.) 1/	400–450	238
(14 from N.Y.) 1/	500–710	252

1/ From Hamilton (1943)
2/ From Burt (1946)
3/ From Soper (1964)

Neither Hairy *Dendrocopos villosus* nor either three-toed woodpecker *Picoides* spp. occurs in sufficient numbers in the Cariboo (Erskine and Stein, 1964) or elsewhere in the northern forests to offer serious competition to sapsuckers as a species; individual cases of competition undoubtedly occur. Although Tree Swallows return in spring earlier than do sapsuckers, they start nesting about the same time, and can hardly be considered as limiting nesting by sapsuckers. Since the sapsuckers usually make a new hole each year, only a species aggressive enough to keep them from using a tree or forceful enough to oust them once they have completed a hole would be a serious competitor. In the main part of their range, neither predation nor nest site competitors seem to exert any important pressure on sapsucker nest site selection, although this may not be true on the southern margin of the breeding area.

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We wish to acknowledge the contributions of nearly 150 observers whose nest records of sapsuckers were examined in this study. Louise deKiriline Lawrence and Robert Gibbon, who studied the species intensively in Ontario and New Brunswick respectively, contributed the largest numbers of cards, but this wide-ranging study became possible only after a large number of volunteers had deposited their data from many areas in nest record schemes. We thank them all, and also the institutions which are sponsoring this valuable program: University of British Columbia, Manitoba Museum of Man and Nature; Royal Ontario Museum; National Museum of Natural Sciences; New Brunswick Museum; Canadian Wildlife Service. C. David Fowle read and commented helpfully on the manuscript.

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Notes

A Plant Collection from the Southern Interior of Banks Island, N.W.T.

In the summer of 1968, the Entomology Research Institute, Canada Agriculture, with the cooperation of the Polar Continental Shelf Project, Department of Energy, Mines and Resources, put a two-man field party in the southern interior of Banks Island, the most westerly island of the Canadian Arctic Archipelago.

Although the objectives of the expedition were mainly entomological, opportunity was taken by both members to make plant collections as circumstances allowed. Since the 122 species collected are all from one inland site and include 14 additions to the island flora, the results are presented here. They raise the number of species known from Banks I. to 186.

1. The Collecting Area

Camp was established at 71° 37′ N, 123° 07′ W, about 15 miles up the Masik River on its north side. At this point the valley has a level floor 2 miles wide, rising steeply to flat moraine terraces of recent origin and then more gently to unglaciated gravelly ridges and knolls at a final elevation of nearly 900 feet and a total width of about 5 miles (French 1969). All plant collections were made in this vicinity (Figs. 3, 4).

2. Climate and Geology

Climatically, the valley is sheltered from the worst effects of coastal conditions, being warmer, drier, and less windy. On many days, clear sky prevails when the coast is shrouded in mist and rain. During the period July 7-17, a stationary high pressure system over the area gave unbroken sunshine with day temperatures of about 70°F.

Fyles (1962) states that the area has undergone multiple glaciations, the latest of which appears to be of Wisconsin age. According to French (1969) the series of gravel-clay terraces that to some extent modify the general topography of the valley in the area of the camp-site, are of morainic origin.

3. Special Features

Porsild (1955) has described plant habitats for the Western Archipelago in general but the following features appear to be worth special mention:

(a) *Barrens* (Fig. 1). The moraine terraces that rim the valley on both sides are composed of almost bare polygons and solifluction stripes of stony clay. Although apparently inactive, they support vegetation only on their margins. The polygon centres frequently have a salt crust; the stones show carbonate concretions below and deep weathering above. A purplish semi-decumbent grass, *Puccinellia poacea,* is widespread on these terraces, and might, at least locally, be added to the list given by Porsild (1955, p. 61) of four ubiquitous species found in such habitats.

(b) *Alluvial* fans (Fig. 3, 4). The terraces have undergone erosion from small tributary streams cutting deep gullies in their walls. Where the gullies debouch onto the valley floor, alluvial fans have been formed, their extent being delineated by thickets of *Salix richardsonii.* The height of these shrubs progresses from about 20 cms at the lower outer margins to 130 cms on the banks of the stream at the mouth of the gully where they terminate abruptly. Here, judging by the size of the plants, soil and moisture are optimal; the limiting factors presumably are excessive accumulation and persistence of snow.

(c) *Black soils* (Fig. 2). A black, fine textured soil, having the appearance of muck, occurs in small areas along the edges of higher terraces and ridges. Being mildly alkaline, with a very low carbon-, and very high clay-content, it is apparently derived by weathering in situ of exposed outcrops of dark Christopher shale. It does not show a frost pattern and appears to be very well drained. Vegetation is far from closed, plants covering less than one third of the surface, but many species grow on this soil, all being dwarfed and several, in addition, rufescent. Flowering is profuse so that we came to recognize such areas from a considerable distance, refering to them as gardens. *Saxifraga tricuspidata* was the commonest species, and *Silene acaulis* grew here exclusively. Other species found were, *Festuca brachyphylla, F. baffinensis, Kobresia myosuroides, Salix arctica, Cerastium beeringianum, Arenaria rubella, Papaver radicatum, Potentilla nivea* var. *hookeriana, P. rubricaulis, Astragalus alpinus, Androsace septentrionalis, Armeria maritima, Polemonium boreale, Plantago septata, Achillea nigrescens, Antennaria eckmaniana, A. compacta, Artemisia hyperborea, Arnica alpina* ssp. *angustifolia* and *Senecio hyperborealis.*

4. Notable Records

Puccinellia arctica — a solitary clump found in a barren mud slope above a snowbank. A few clumps of *Phippsia algida* and *Artemisia tilesii* were also found here but nowhere else.

Puccinellia poacea — see note under "barrens" above.

Carex lugens — in a moist turfy gully.

Juncus balticus var *alaskanus* — common in moist alluvial clay of the valley bottom.

Salix richardsonii — together with much smaller numbers of *S. alaxensis* forms dense thickets covering hundreds of acres of the valley floor, wetter parts of the lower terraces and outwash fans. The thickets are commonly 20 to 50 cm tall but occasional plants reach over 1 m., such profuse growth being probably unmatched elsewhere in the western arctic islands (Porsild 1955, p. 66).

Salix reticulata — mostly sterile, even in 1968, a very warm season.

Halimolobis mollis — turf on a high gravelly hilltop that is evidently used as on owl perch.

Braya thorild-wulfii — in a well sheltered turfy gully.

Parnassia kotzebuei — alluvial clay and late snow area in a gully.

Cassiope tetragona — in seepage areas with southern exposure below vernal snowbanks; only a few unthrifty and sterile patches seen.

Arctostaphylos rubra — sheltered turfy places with southern exposure; scarce and sterile.

Artemisia hyperborea — dry tundra, especially around owl perches.

Within the Arctic Archipelago, the following five species have been found only in the Masik River Valley: *Elymus innovatus* (Cody 1965), *Salix glauca, Arenaria capillaris* var. *nardifolia* (Porsild 1943), *Pulsatilla ludoviciana* (Manning 1953) and *Achillea nigrescens*. All grow on turfy slopes with southern exposure on the lower moraine terraces. The first species was found only once, on freshly dug earth around a lemming burrow.

Most of the novelties in Table I represent northern extensions of the ranges of mainland species and are probably all post-glacial invaders. Two species (*Puccinellia poacea* and *Braya thorild-wulfii*) however, represent southward extensions of high arctic species (Porsild 1964). They add to the possibility that Banks Island was the chief glacial refugium for most of the arctic archipelago endemics (Porsild 1955, p. 52-53, 1964, p. 58).

5. Check List

Mr. W. J. Cody, Plant Research Institute, Canada Department of Agriculture, Ottawa, identified the specimens which are preserved in the Phanerogamic Herbarium of that Institute.

Equisetum arvense, Alopecurus alpinus, Phippsia algida, Arctagrostis latifolia, Deschampsia brevifolia, Trisetum spicatum, Poa alpigena var. *alpigena, Poa alpigena* var. *colpodea, Poa arctica, Poa glauca, Arctophila fulva, Colpodium vahlianum, Dupontia fischeri* spp. *fischeri, Puccinellia arctica, Puccinellia poacea, Festuca brachyphylla, Festuca baffinensis, Festuca rubra* ssp. *richardsonii, Agropyron violaceum, Elymus innovatus, Eriophorum triste, Eriophorum scheuchzeri, Kobresia myosuroides, Carex lugens, Carex aquatilis* var. *stans, Carex membranacea, Juncus balticus* var *alaskanus, Juncus biglumis, Luzula nivalis, Luzula confusa, Salix richardsonii, Salix reticulata, Salix polaris* ssp. *pseudopolaris, Salix alaxensis, Salix niphoclada, Salix glauca, Salix arctica, Oxyria digyna, Polygonum viviparum, Stellaria monantha, Stellaria laeta, Cerastium beeringianum, Cerastium regelii, Silene acaulis* var. *exscapa, Arenaria rubella, Arenaria capillaris* var *nardifolia, Melandrium apetalum* ssp. *arcticum, Melandrium ostenfeldii, Caltha palustris* var *arctica, Anemone parviflora, Pulsatilla ludoviciana, Ranunculus gmelinii, Ranunculus nivalis, Ranunculus pedatifidus* var. *leiocarpus, Ranunculus pygmaeus, Papaver keelei, Papaver radicatum, Eutrema edwardsii, Cardamine digitata, Lesquerella arctica, Draba bellii, Draba cinerea, Draba glabella, Druba subcapitata, Halimolobus mollis, Erysimum pallasii, Braya thorild-wulfii, Parrya arctica, Saxifraga caespitosa* ssp. *uniflora, Saxifraga cernua, Saxifruga hirculus* var. *propinqua, Saxifraga nivals, Saxifraga oppositifolia, Saxifraga tricuspidata, Chrysosplenium tetrandrum, Parnassia kotzebuei, Potentilla nivea* ssp. *hookeriana, Potentilla rubricaulis, Dryas integrifolia, Astragalus alpinus, Astragalus richardsonii, Oxytropis arctica, Oxytropis arctobia, Oxytropis glutinosa, Hedysarum alpinum* var. *alpinum, Hedysarum mackenzii, Epilobium latifolium, Hippuris vulgàris, Cassiope tetragona, Arctostaphylos rubra, Androsace septentrionalis, Androsace chamaejasme* var. *arctica, Armeria maritima* ssp. *labradorica, Pole-*

TABLE 1. — Species new to the flora of Banks Island

Species	New to: Banks Islands	Western Islands	Archipelago
Poa alpigena var. *alpigena*	x	x	
Puccinellia arctica	x		
Puccinellia poacea	x	x	
Dupontia fisheri ssp. *psilosantha*	x	x	
Elymus innovatus	x	x	x
Juncus balticus var. *alaskanus*	x		
Salix glauca	x	x	x
Arenaria capillaris var. *nardifolia*	x	x	x
Melandrium ostenfeldii	x		
Halimolobis mollis	x	x	
Braya thorild-wulfii	x		
Parnassia kotzebuei	x	x	
Arctostaphylos rubra	x	x	
Antennaria ekmaniana	x	x	
Artemisia hyperborea	x		
Achillea nigrescens	x	x	x

FIGURE 1. Barrens; moraniic terrace of stony clay with inactive polygons and stripes. Vegetation almost confined to grooves between the polygons.

FIGURE 2. Black soil area; fine textured and unpatterned soil with only partial cover of vegetation.


3


4

monium boreale, Castilleja pallida ssp. *elegans, Pedicula is arctica, Pedicularis capitata, Pedicularis lanata. Pedicularis sudetica, Plantago septata, Achillea nigrescens, Erigeron compositus, Erigeron eriocephalus, Erigeron unalaschkensis, Antennaria compacta, Antennaria ekmaniana, Chrysanthemum integrifolium, Artemisia hyperborea, Artemisia richardsoniana, Artemisia tilesii, Petasites frigidus, Arnica alpina* ssp. *angustifolia, Senecio atropurpureus, Senecio congestus, Senecio hyperborealis, Taraxacum hyparcticum, Taraxacum laceum, Taraxacum phymatocarpum, Taraxacum pumilum.*

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FIGURE 3. Late snow patch. Gully occupied by snow in early July. (The snow was totally melted by early August.) At the right snow patch vegetation is emerging; mud banks at the left bear the only local stands of *Phippsia algida, Puccinellia arctica,* and *Artemisia tilesii.* An alluvial fan with willow thicket extends from the gully mouth (near the insect trap) to the river.

FIGURE 4. Alluvial fan. Upper terminus of a thicket of willows (*Salix richardsonii*) at the head of an alluvial fan. (The handle of the butterfly net is 0.9 m long.) The flat bottom of the Masik Valley extends about three miles to the south rim.

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W. R. M. MASON[1]
G. E. SHEWELL[1]
W. J. CODY[2]

[1]Entomology Research Institute
Canada Department of Agriculture, Ottawa
[2]Plant Research Institute
Canada Department of Agriculture, Ottawa

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Woodsia scopulina in Algonquin Park, Nipissing District, Ontario

Abstract. The present status of *Woodsia scopulina* in Algonquin is discussed. Two new stations of this rare *Woodsia* are reported. Some ecological notes are included.

In the summer of 1915, Frank Morris, while botanizing the wooded hills of Algonquin Park near Cache Lake, discovered a colony of *Woodsia scopulina* D. C. Eaton (*Woodsia oregana* D. C. Eaton var. *Lyallii* (Hooker) B. Boivin) (Boivin 1966). The discovery was reported by Wherry (1934), who described the station. Although there seemed to be nothing unique about the location, no new stations of this rare *Woodsia* were discovered in Algonquin until 1971. That year, the author and his field partners, while participating in a biological survey of the park, located two additional stations. The only other area of Ontario where this fern occurs is near the north shore of Lake Superior in Thunder Bay District (Brown

1964). Several stations are known there. Elsewhere in Eastern Canada, this predominatly western fern is known only from the Gaspé Peninsula of Quebec (Brown 1964, Scoggan 1950).

The first new location was on granitic rock faces of a wooded section of a large cliff at Carl Wilson Lake in Lister twp. The cliff where the Woodsia grew was in three steps. Each step was interrupted by moderately steep slopes. The fern grew on the cliff parts, which averaged about 30 feet in height. The forest on the slopes was mainly coniferous. Hemlock (*Tsuga canadensis*) and White Cedar (*Thuja occidentalis*) were the predominant trees. Fern associates were *Dryopteris fragrans, Cystopteris fragilis* and *Woodsia ilvensis.* The population here was estimated at 125 individuals. Specimens were collected and deposited in the following herbaria: OAC, TRT, DAO and the herbarium of the Algonquin Park Museum.

The other new location was at Tarn Lake in Master twp. The plants grew on a low, 40 foot high section of a huge granite cliff beside the lake. The cliff was open in its high sections but was merely a woodland cliff through hardwoods where the *Woodsia* grew. Fern associates were *Cystopteris fragilis* and *Woodsia ilvensis.* The number of plants was estimated at 50. Collections were made and deposited in DAO and the herbarium of the Algonquin Park Museum.

It is of interest to note that the original colony found by Professor Morris at Hilliard Lake in Canisbay twp., near Cache Lake, is extant. It too is on a granite woodland cliff near a small lake. The cliff here is about 26 feet high and through mainly coniferous woods. *Cystopteris fragilis* grew with the *Woodsia* at this station, the pH of the soil in which the fern grew was determined from 5 sites on the cliff. The results ranged from 4.4 to 6.0 with a mean of 5.0. This indicates that, at least in Algonquin, the *Woodsia* prefers a mediacid substrate. This preference was also presumed from the nature of the rock at the other locations. However, in the Gaspé Peninsula, Scoggan (1950), considers this species to be a calciphile.

Counts of the number of plants present at this station have been taken at various times since its discovery. These counts indicate that, although it has varied in size, it is perhaps not significantly smaller at present than when first found. *Morris reported 50 plants in 1915; 15 plants were reported by Wherry (1934) and recent observations in 1969 and 1970 disclosed about 30 plants. The colony is not dwindling as Wherry (1934) thought. This station is well represented by collections. These have been cited by Brown (1964). The collection localities are given either as Cache Lake or Hilliard Lake but both refer to the same station.

These locations in Algonquin are not strikingly exceptional aside from the presence of the *Woodsia.* Observed common factors are low, wooded cliffs; acidic substrates and locations adjacent to lakes. These are all very general and met at many localities. It is thus unusual that the fern has been found in only two widely separate areas in Ontario. Although it is undoubtedly quite rare, the possibility that it has been overlooked in other regions must be considered.

*Note on herbarium sheet (Morris in 1915, CAN No. 89614).

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TONY A. REZNICEK

Department of Botany,
University of Toronto,
Toronto, Ontario

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Nest Parasitism at McConnell River, N.W.T.

During the course of studies on Canada Geese (*Branta canadensis hutchinsii*) and Blue Geese (*Anser caerulescens*, including both "Snow" and "Blue" phases, after Cooch, 1961), at the McConnell River, N.W.T. (60°50′N, 94°25′W), we have noted several instances where eggs of these two species as well as those of Common Eiders (*Somateria mollisima*) and Willow Ptarmigan (*Lagopus lagopus*) were laid in nests of other species. Casual nest parasitism has been recorded more frequently for waterfowl than any other group of birds. Species combinations listed here, however, have not previously been reported (Pelzl 1971, Weller 1959).

Nests Laid in by Blue Geese

CANADA GOOSE. Blue phase goslings have been found at nests of Canada Geese three times at McConnell River. In each case they hatched before the Canada Goose eggs in the same nest. Other observations at McConnell River have indicated that the incubation period for Blue Geese is about a day shorter than that for Canada Geese. Survival of the Blue goslings was poor. One hatched 2 days before the Canada eggs in the same nest and had disappeared the day after it hatched. A second Canada Goose nest contained a day old Blue gosling and 5 pipping eggs on 12 July 1969. The pair of neck-collared Canadas left the nest when approached by an observer and on 18 and 19 July this pair was seen with no goslings. The third Blue gosling was seen with its marked "parents" and 3 Canada Goose brood mates on 6 occasions during the brood-rearing period and was later caught with them in a banding drive. In a fourth case, a Blue gosling was found beside a Canada Goose nest containing 3 Canada goslings. It is possible that the Blue gosling had hatched in the Canada Goose nest, or, it could have been killed by the Canada pair when a brood of Blue Geese ventured too near.

COMMON EIDER. *Somateria mollissima*. Lieff (1969) found an eider nest on an island in the McConnell River delta on 23 June, 1967, containing four eider eggs and a goose egg. All eggs hatched on 9 July and a Blue gosling left the nest with the eider family. The fate of the gosling was unknown although it had difficulty following the eiders in the swift-flowing water of the delta channels and when last seen was trailing far behind the eider family.

HERRING GULL. *Larus argentatus*. In 1967 goose eggs were twice found in gull nests. One nest contained a single goose egg on 17 June. A gull was sitting on the nest when the observer approached and it later returned and stood beside the nest. On 4 July the goose egg had disappeared but three gull eggs were present. The second nest contained one gull egg and one goose egg, which were being incubated by a gull on 3 July. Four days later the gull egg was pipping and shell fragments indicated that the goose egg had already hatched. It is possible that the gosling was killed and eaten by its foster parents; gulls are the chief predators of goslings at McConnell River. Since both nests were located among nesting Blue Geese, it is assumed the goose eggs belonged to this species.

SANDHILL CRANE *Grus canadensis*. In 1966 two Sandhill Crane nests were found containing one goose and one crane egg, and one goose and two crane eggs (Fig. 1), respectively. Both nests were being incubated by cranes. The fate of the goose eggs was not determined. The eggs were likely those of Blue Geese since both crane nests were closely associated with Blue Goose nests.

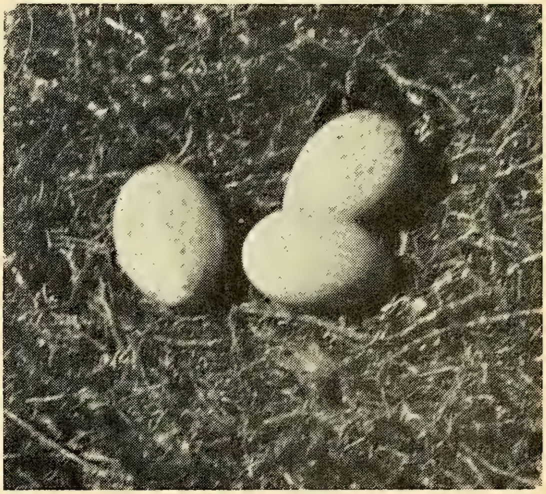

FIGURE 1. Sandhill crane nest at McConnell River, N.W.T. with 2 crane eggs (mottled) and one Blue Goose egg.

Nests Laid in by Canada Geese

COMMON EIDER. On June 16, 1965, a ♀ Common Eider was flushed from a nest containing five

Eider eggs and a goose egg. This nest was not visited again. The site was similar to those usually selected by Canada Geese and in an area containing several Canada Goose nests suggesting that the goose egg was a Canada's.

BLUE GOOSE. We have never found Canada goslings hatching in Blue Goose nests. However, although the evidence is circumstantial, a report of a Canada Goose wearing a neck collar fitting the description of those used by Prevett on Blue Geese suggests such an occurrence. The Canada was seen in a flock of approximately 10,000 Blue Geese at the Plattsmouth Waterfowl Management Area, Plattsmouth, Nebraska, on 16 April, 1971. (G. Drown, pers. comm.). Since this bird was the only Canada in the Blue Goose flock and since it apparently wore a Blue Goose neck collar, it was possibly hatched in a Blue Goose nest and mistakenly banded as a Snow-phase gosling during mass banding drives for Blue Geese at the McConnell River 5 to 6 weeks following the hatching period. If this was the case, the Canada Goose was probably still associated with its foster family when sighted at Plattsmouth.

Nests Laid in by Common Eider

CANADA GOOSE. A nest found on 13 June, 1965, with a single Canada Goose egg contained two Canada eggs and a Common Eider egg on 14 and 15 June but had been destroyed when next visited on 27 June.

Nests Laid in by Willow Ptarmigan

BLUE GOOSE. A goose nest in the Blue Goose colony containing one goose egg and two ptarmigan eggs was found on 17 June 1967. Although incubation had begun in virtually all Blue Goose nests at this time, there was no down in the nest and attendant geese were not present. When revisited on 4 July the nest had been destroyed. An intact ptarmigan egg was found 2 m from the

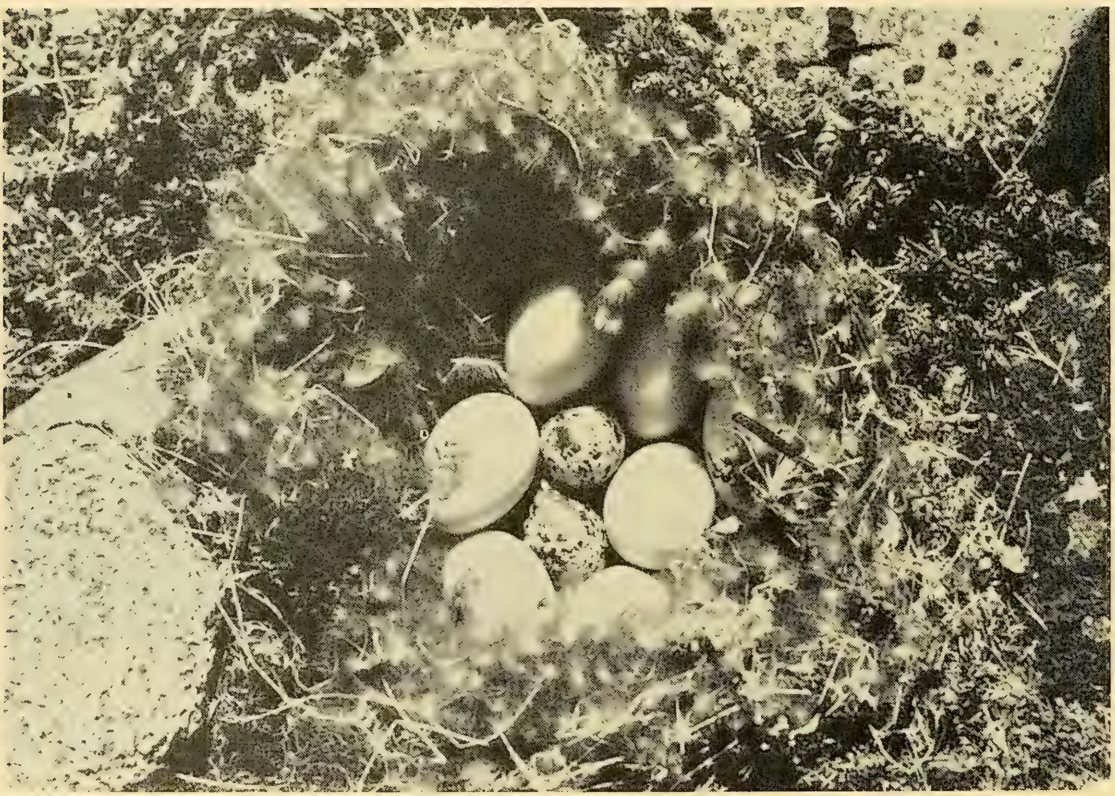

FIGURE 2. Pintail nest at McConnell River, N.W.T. with 7 Pintail eggs (large, plain) and 2 Willow Ptarmigan eggs (smaller, mottled).

nest and shell fragments of a goose egg and a ptarmigan egg were in the nest cup.

PINTAIL *Anas acuta*. On 23 June 1968, a ♀ Pintail flushed from a nest containing 9 Pintail and two ptarmigan eggs (Fig. 2). Although 2 ♀ Willow Ptarmigan were nearby, we found just one nest with four eggs 15 m from the Pintail nest.

Discussion

Weller (1959) has reviewed probable factors affecting non-obligate egg parasitism by waterfowl and gallinaceous birds and Gotzman (1967) presented an interesting hypothesis on the cause of a Little Ringed Plover (*Charadrius dubius*) laying an egg in the nest of a Common Tern *Sterna hirundo*) after the plover's first clutch was destroyed due to flooding. At the McConnell River, a shortage of suitable nest sites during the period of nest initiation appeared to be the major factor causing individuals to lay eggs in nests other than their own. Up to 100,000 Blue Geese nest over an area of approximately 125 km² at the McConnell River. Several other species of birds, including those involved in the parasitized nests, also nest in and around the Blue Goose colony. Due to the shortness of the arctic summer, birds with long incubation and rearing periods must begin nesting as soon as suitable habitat is available. Snow-free areas are often scarce at the time of nest initiation and competition for nest sites, particularly among Blue Geese, can be violent. Territoriality may break down, especially in late seasons when snow clears slowly, resulting in widespread intraspecific egg-dumping by Blue Geese (Barry 1962, Cooch 1958). In 1968, a very late year phenologically at the McConnell River, Prevett found many deserted Blue Goose dump nests containing up to 41 eggs. Information obtained from a 4 km nest transect involving 153 Blue Goose nests indicated that a minimum of 20% of all eggs laid were "dumped" (L. S. Prevett, unpub. data). (Dump eggs were those laid beside nests and eggs laid in excess of 1 during a 24 hour period, after Cooch 1958: 61). Even in normal seasons early nesting pairs may be unable to obtain nest sites at the required time. Females with no nests of their own but with eggs ready to be laid are possibly stimulated by the sight of eggs to lay in nests regardless of the species.

It is not surprising that Canada Geese, eiders, cranes and Herring Gulls, all initiating nests at the same time in close proximity to the dense blue goose colony and at a time when suitable sites are often not plentiful, are sometimes parasitized by Blue Geese. Similarly, competition for nest sites between Canada Geese, which favour islands in small tundra ponds, and common eiders, which often use identical sites, can be expected to result in occasional egg parasitism or appropriation of nests already laid in by the other species. Under similar circumstances at the Yukon-Kuskowim delta, Alaska, P. Mickelson (pers. comm.) has found several instances of eggs of Cackling Geese (*Branta canadensis minima*) and Spectacled Eiders (*Lampronetta fischeri*) in nests being incubated by females of the other species.

Despite widespread egg-dumping by Blue Geese in late seasons, regular parasitism has not become common. Among the cases of inter-specific egg-laying noted at the McConnell River, only Blue and Canada goslings hatched in nests of the other species would be likely to survive. Behavioral, physiological and ecological differences between geese, eiders, Pintails, cranes, ptarmigan and gulls seem likely to prevent successful rearing of young with the other combinations of species reported here. Although young of species that laid parasitic eggs in this study are precocial, they are unlikely to survive by striking out alone (as do young of the frequently parasitic Redhead, *Aythya americana* and Ruddy Duck, *Oxyura jamaicensis*, Weller 1959) since they require nearly constant protection from predators as well as frequent brooding in the often harsh arctic summer.

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J. P. PREVETT, B. C. LIEFF, C. D. MACINNES

Department of Zoology,
University of Western Ontario
London 72, Ontario

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Arctic Loon Breeding in Alberta

There is uncertainty about the southern boundary of the breeding range of the Arctic Loon (*Gavia arctica*) in the area of the northern Alberta boundary. This is indicated by a question mark in this part of the map of the breeding range of this loon in Godfrey's (1966) "The Birds of Canada." Salt and Wilk (1966) state as the only evidence of breeding of this species in the province, that "there is a single record of nesting on Lake Athabasca east of Fort Chipewyan".

The only record I have been able to find that fits this is a statement by R. MacFarlane (1908, p. 295), "Early in June, 1885, a half-breed hunter brought into Fort Chipewyan . . . the female parent with a set of eggs which he claimed to have obtained from her nest. The latter he states was a mere depression in the ground on the margin of a large pond or sheet of water. Both (presumably the skin and the eggs) were forwarded to Mr. Dalgleish, who also identified them as *Urinator arcticus* — the old name of this loon."

MacFarlane's account does not indicate in which direction from Chipewyan or how far away the nest was. The record cannot therefore be located with certainty in terms of present political areas since Chipewyan is relatively near the border between Alberta and the Northwest Territories as well as the Alberta/Saskatchewan boundary. In view of this, the observations recorded below appear to furnish the first definite evidence of breeding of this loon in Alberta.

In early July, 1971, I spent four days on Leland lake, north of Lake Athabasca, which extends north and south across the Alberta/Northwest Territories boundary. Our camp was about six miles south of this boundary and about thirty miles east of Fort Smith. On July 5, I walked to a small lake, about a quarter of a mile across, east of Leland Lake and from a distance saw a loon, whose call sounded unlike that of the Common Loon (*Gavia immer*), which was often seen on Leland Lake itself. When I reached the shore of the lake, the bird had disappeared. On July 7, I saw an unmistakable Arctic loon on another small lake in the same general area. When on July 8 I revisited the first-mentioned small lake, I found an Arctic Loon there which slowly swam away at my approach, with the neck erect and calling "karr karr". After a while, I saw that it was swimming towards another loon of this species which was near a marshy section of the shore (much of the lake shore was rocky), across from me and that there was a downy youngster swimming beside it, which at times perched on the adult's back.

As to the identification of these loons, I would state that I am familiar with the Arctic Loon and its relatives from experience in the Northwest Territories in earlier years. The pale grey top of the head and nape, and the beak, much smaller than that of the Common Loon, were noted at the time. The small lake which held the breeding pair, has no name, but the name Arctic Loon lake has been suggested for it in a submission to the Alberta Board of Geographical Names.

Since an Arctic Loon was also seen on another lake in this area, and since I examined only three of the small lakes in the vicinity on foot, there may well be more than one breeding pair in this area.

The study, of which my visit to Leland Lake was part, was supported by a grant from the Boreal Institute of the University of Alberta. I am obliged to Mr. C. Smith, general manager Eldorado Nuclear Corporation, for transportation to Lake Athabasca.

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E. O. HÖHN

Department of Physiology,
University of Alberta,
Edmonton, Alberta,
Canada.

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Summer Foods of American Widgeon, Mallards, and a Green-winged Teal near Great Slave Lake, N.W.T.

Abstract. Foods found in three species of dabbling ducks collected during summer from bog ponds, and sedge pools in taiga on the north side of Great Slave Lake, Northwest Territories, are described. Animal material in the esophageal contents of 10 adult American Widgeons (*Mareca americana*) averaged 31 ± 34 per cent ($P<0.05$) by volume. A significantly higher percentage of animal material was found in Class I and II widgeon ducklings (66 ± 22 per cent) than in Class IIIa ducklings and flying juveniles (12 ± 20 per cent) of this species. Animal material comprised 87 ± 35 per cent of esophageal contents from five Class II and flying juvenile Mallards (*Anas platyrhynchos*) and 100 per cent of that from an adult female Green-winged Teal (*A. carolinensis*).

Introduction

American Widgeons, Mallards, and a Green-winged Teal were collected from June through September 1967 from subarctic taiga in the vicinity of the Yellowknife Highway, near Yellowknife, Northwest Territories. The purpose of this study was to determine the summer foods of the more abundant species of waterfowl, particularly juveniles, in this area. Summer foods of Lesser Scaup (*Aythya affinis*), most numerous of ducks in this locality, and the wetland habitat are described elsewhere (Bartonek and Murdy 1970).

Methods

Procedures (Swanson and Bartonek 1970) for obtaining food samples from ducks included: (1) collecting actively feeding birds; (2) using for analyses only materials taken from the esophagus in order to avoid foods subjected to physical or chemical breakdown; and (3) immediately removing and preserving the foods in ethanol in order to stop post-mortem digestion. Generally no more than two birds per flock or brood were collected. Foods were identified, segregated, external moisture removed and volumes measured by liquid displacement. Juvenile birds were aged and classified according to plumage development (Gollop and Marshall 1954).

Results

Five male and five female adult American Widgeon collected between June 10 and August 4, 1967, contained averages of 23 ± 54 per cent ($P<0.05$) and 40 ± 68 per cent animal material, respectively. Two adult females were collected in June, one of which had an egg in her oviduct, had consumed only animal foods, whereas three females collected in late July and early August had consumed only plant material. Sexes were combined in this small sample to give an average of 31 ± 34 per cent animal material (Table 1). Larval and adult midges (Chironomidae) accounted for over 99 per cent of the dipterans eaten; adult mosquitoes (Culicidae) and adult blackflies (Simuliidae) accounted for the remaining trace. Adult damselflies and dragonflies (Odonata), larval predaceous diving beetles (Dytiscidae), and adult leaf beetles (Chrysomelidae) comprised the remainder of the animal food. Vegetative portions of plants comprised 97 per cent of plant material consumed. Blades of sedges (*Carex* sp.) and grasses and foliage of pondweeds (*Potamogeton* spp.), horsetails (*Hippuris* sp.), and mosses (*Drepanocladus* sp.) were important in the diets of individual birds, but they were seldom found in more than two birds. Achenes of sedges were found in one bird, and nutlets of pondweed were found in two other birds. Additionally, nutlets of slender bur-reed (*Sparganium minimum*) and water crowfeet (*Ranunculus* sp.) and utricles of water hemlock (*Cicuta* sp.) were found in gizzards; but they were not measured because of the bias which inflates the importance of the less readily digested foods in the diet (Swanson and Bartonek 1970).

Sixteen nonflying juvenile American Widgeon ranging in age from Classes Ib to IIc (median, Class IIa — 19 to 26 days) and collected between July 18 and August 7, 1967, contained an average of 66 ± 22 ($P<0.05$) per cent animal material in their esophagi. This was significantly more than the average of 12 ± 20 per cent animal in material taken from two nonflying juveniles (Class IIIa — 42 to 50 days) and nine flying juveniles (7 weeks or older) collected between August 21 and September 8, 1967.

Juvenile American Widgeon of both groups contained a diversity of animals and plants, with only a few items being consumed by many individuals in either group (Table 1). Among the animal foods, nymph and emerging adult mayflies (Ephemeroptera) and larval and adult caddis flies (Trichoptera) occurred most often; they were found in 6 and 8 birds, respectively, of the 27 juveniles. Seventy-one per cent of the average percentages of volume of animal material from

TABLE 1. — Occurrence and average percent of volume of foods in the esophagi of adult (10 birds), Classes I and II juvenile (16 birds), and Class III and flying juvenile (11 birds) American Widgeon collected near Yellowknife, Northwest Territories, during the summer of 1967.

Food Items	Occurrence			Percent of volume		
	Adults	Juveniles		Adults	Juveniles	
		Classes I & II	Class III & flying		Classes I & II	Class III & flying
Clam shrimps (Conchostraca)		2	1		10	1
Water fleas (Cladocera)		2			3	
Amphipods (Amphipoda)			2			8
Mayflies (Ephemeroptera)		6			24	
Dragonflies and damselflies (Odonata)	1	2		7	4	
Water boatmen and water striders (Hemiptera)		4			4	
Caddis flies (Trichoptera)		6	2		12	tr.
Leaf beetles and predaceous diving beetles (Coleoptera)	1	1	3	3	tr.	3
Midges, blackflies, mosquitoes and horseflies (Diptera)	4	4		22	4	
Miscellaneous and unidentified animal material		7	2		6	tr.
TOTAL ANIMAL MATERIAL	*4*	*15*	*4*	*31*	*66*	*12*
Filamentous algae (Chlorophyceae)	1	2		tr.	2	
Mosses (*Drepanocladus* spp.) – foliage	1	3	2	8	15	16
Horsetails (*Equisetum* spp.) – foliage	2	1		10	1	
Pondweeds (*Potamogeton* spp.) – foliage	1	4	2	10	13	11
Bladderworts (*Utricularia* spp.) – foliage		1	9		1	59
Miscellaneous and unidentified plants – foliage	4	4		38	2	
Miscellaneous plants – seeds, fruits	3	1	5	2	tr.	1
TOTAL PLANT MATERIAL	*8*	*10*	*11*	*69*	*34*	*88*

both age groups of juvenile ducks were comprised of adult and immature aquatic invertebrates, excluding the flying adults of aquatic insects. These flying adults and the terrestrial invertebrates comprised the remaining 29 per cent. Vegetative portions of plants were consumed in greater quantities than seeds (97 per cent *vs.* 3 per cent of the average percentages of volume of both groups). Bladderworts (*Utricularia* spp.), pondweeds, and mosses were the most frequently consumed foliages.

Four Class IIc (36 to 45 days) and one flying (52-50 days) Mallards collected between July 19 and August 8, 1967, average 87 ± 35 per cent animal material in esophageal contents. Average per cent of volume for animal items included: amphipods (Amphipoda), 28 per cent; larval horseflies (Tabanidae), 12 per cent; larval predaceous diving beetles, 12 per cent; adult mayflies, backswimmers (Notonectidae) and adult leaf beetles, each 11 per cent; damselflies, 2 per cent; and leeches (Hirudinea), clam shrimps (Conchostraca), waterboatmen (Corixidae), larval caddis flies and snails (Gastropoda), each 1 per cent. Larval cases of caddis flies were a prominent (60 per cent) item in material from the gizzards of these birds. Nutlets of pondweeds, 13 per cent, and achenes of sedges, trace, comprised the plant material. Except for trace amounts in two juveniles, the plant material was attributable to one bird, the flying juvenile.

An adult female Green-winged Teal collected on September 2, 1967, contained only animal material in her esophagus. Mollusca was the most important phylum and was represented by orb snails (Planorbidae), 22 per cent; pouch snails, (Physidae), 12 per cent; round-mouthed snails, (Valvatidae), 10 per cent; and fingernail clams (Sphaeriidae) 1 per cent. Insects were represented by damselflies, 20 per cent; caddis flies, 18 per cent; and midges, 3 per cent. Amphipods (*Hyalella azteca*) contributed 5 per cent of the total. Seeds

of slender bur-reed, pondweeds, sedges, and horsetails were found only in the gizzard.

Discussion

The summer foods of the American Widgeon taken in this study are akin to those reported elsewhere. Munro (1949) found the foods of 10 downy young American Widgeon from British Columbia to be 88 per cent animal matter, chiefly larval midges and larvae and nymph dragonflies and damselflies. He characterized the 54 adult widgeon that were collected from fall through spring as being mainly vegetarians that fed upon foliage and stems of aquatic plants to a greater extent than almost any other species of dabbling duck. However, this study shows animal material to be an important part of the diet of some adults of either sex during the summer. I believe that a larger sample of adults taken during the nesting season would have shown that females consumed significantly more animal material than males. Sugden (1969) found in a sample of 129 juvenile widgeon collected in southern Alberta that mostly surface invertebrates were eaten at first and later replaced in the diet by aquatic invertebrates and plant foods as the ducks grew. Insects made up the bulk of the animal food. Slender pondweed (*Potamogeton pusillus*) comprised 59 per cent of the plant food; and filamentous algae (Chlorophyceae) contributed 20 per cent.

Diets of the juvenile widgeon reported in this study apparently changed with age (i.e., they ate progressively more plant material as they became older) as did those reported by Munro (1949) and Sugden (1969).

Chura (1961) noted that Mallards from Utah underwent a progressive shift from almost entirely invertebrate foods in Class Ia ducklings to almost entirely plant foods in Class III and older juveniles. The small sample of four Class IIc and one flying juvenile Mallards from this study contained 99 and 35 per cent animal matter, respectively, which differed considerably from those percentages reported by Chura which were 11 per cent and trace (unspecified sample sizes) for the same age groups, respectively. Perret (1962) did not detect any differences among the predominately animal diets of three nonflying age-classes of juvenile Mallards from Manitoba; however, the foods found in these 54 nonflying juveniles (94 ± 4 per cent animal material) differed, but not significantly ($P<0.05$), from those in 8 flying juveniles (71 ± 36 per cent animal material).

Perret (1962) believed that the differences in diets were attributable mainly to availability and abundance of food items within the birds' feeding range, i.e., they must feed upon that which is available. Changing nutritional requirements and adaptive feeding behavior of birds may be equally or more important in determining the quantity of animal versus plant matter consumed. Bartonek and Murdy (1970) demonstrated that Lesser Scaup seldom or never ate certain abundant and readily available organisms but that they would consume other organisms in proportions that were not significantly different ($P<0.05$) from those found in the habitat.

Foliage of bladderwort (*Utricularia* spp.), mostly winter-buds, was consumed by 10 young widgeon in this study. Martin and Uhler (1939) found no record of this plant being used by ducks taken throughout most of North America; however, they believed that if used it was only of limited local value.

The foods found in 25 adult and 38 juvenile Lesser Scaup that were collected concurrently with the dabblers in this study, but reported elsewhere (Bartonek and Murdy 1970), were almost entirely animal material (99 ± 1 per cent, $P<0.05$). Juvenile Lesser Scaup collected in mid-summer had tended to feed on free-swimming organisms such as phantom midge larvae (Chaoborinae) and clam shrimps; whereas juveniles collected in late summer had tended to feed, as did adults in June, on bottom-associated organisms such as amphipods, odonates, and corixids. Unlike the dabblers of this study, the Lesser Scaup were not found to contain either flying forms of aquatic insects or terrestrial insects; and they did not show a shift from animal to plant foods with increasing age.

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JAMES C. BARTONEK

Bureau of Sport Fisheries and Wildlife,
Northern Prairie Wildlife Research Center,
Jamestown, North Dakota 58401, U.S.A.

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Predation at a Northern Yukon Bank Swallow Colony

During late July 1970, while conducting archaeological survey operations along the Old Crow River in northern Yukon Territory, I had occasion to observe numerous colonies of Bank Swallows (*Riparia riparia*). These colonies often include a hundred or more nesting holes though not all are occupied simultaneously. The holes are excavated in alluvial silts and clays which have been exposed by the continuous dissection of the Old Crow River. On 30-31 July I was able to spend several hours at a large colony (ca. 150 holes) three miles below the mouth of Schaeffer Creek on the left bank of Old Crow River (67°50′ N, 139°58′ W.). This colony was situated in a north-facing bank about 30 feet high, and the distribution of active nests had gradually shifted upstream along the bank as the Old Crow River had eroded a sharp point at the downstream end. Erosion had exposed the interiors of several formerly deep swallow burrows, and I was unable to establish the precise number of active holes still remaining in the colony.

Two agencies of predation were noted at the colony. Fourteen holes in the relatively shallow downstream part of the bank had been opened by a bear shortly before my arrival. Eggs and/or young birds could have been obtained by the bear, and large, deep claw marks were clearly evident along a portion of the bank about 20 feet in length. A brown bear (*Ursus americanus*) and two cubs were observed directly across the river on the evening of 31 July and they may have been responsible for the excavations at the colony. Upon my arrival I found a dead adult swallow at the water's edge, but I could not determine the cause of death.

I set two 30-foot mist nets in front of the bank, and succeeded in banding 50 swallows. The shortness of time prohibited extensive observations, but numerous repeats of banded swallows clearly indicated that individual birds did not always return to the same holes. During a brief absence from the nets for a 15 minute supper on 30 July, a Northern Shrike (*Lanius excubitor*) appeared on the scene. As I returned the shrike flew from a low perch behind the mist net to a higher one on the top of the bank. Directly in front of the shrike's perch was a dead swallow still in my net, and a small hole surrounded by fresh blood was visible on the swallow's head. Apparently the shrike attempted to steal the swallow from the net, because the bird was badly tangled and difficult to remove. I have seen in the literature only a few scattered reports of this sort of predation during mist-netting operations, but none to my knowledge has involved a shrike. Nor have I noticed at any of the many other Bank Swallow colonies in northern Yukon any evidence that bears had attempted to obtain eggs or young birds.

RICHARD E. MORLAN

Archaeological Survey of Canada,
National Museum of Man,
Ottawa, Ontario.

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The Eastern Chipmunk, *Tamias striatus,* in Southwestern Minnesota, U.S.A.

Abstract. A population of the eastern chipmunk, *Tamias striatus,* occurs at Lake Shetek State Park, Murray County, Minnesota. Report of this population fills in an important gap in the overall range of the species. The chipmunks are sympatric with *Spermophilus tridecemlineatus,* which show marked contrast in burrow preferences.

The eastern chipmunk, *Tamias striatus,* has not been reported from southwestern Minnesota. Gunderson and Beer (1953) state that it is found in all but the southwestern counties of the state. Hall and Kelson (1959) do not include southwestern Minnesota within the range of this species, but instead show the range looping around southwestern Minnesota from northcentral Iowa to northeastern South Dakota.

A population of *Tamias striatus* has been observed on a number of occasions during field work at Lake Shetek State Park, Murray County, Minnesota. Because of state regulations, no specimens have been collected from the park. The chipmunks are most common in the woodland between the bathing beach and main picnic grounds and the boat dock. In this area they are sympatric with a larger colony of *Spermophilus tridecemlineatus.* The *Spermophilus* occur in the open picnic grounds and in the open spaces along the pathways and roads surrounding the woodland in which the *Tamias* occur. There is a marked contrast in the selection of burrow sites by the two squirrels. The burrows of *Tamias* are located in hollow trees and logs, while those of *Spermophilus* are dug in the ground. No direct competition has been observed between these species, but the chipmunk population is decidedly smaller and more restricted in total area.

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CARL H. ERNST and EVELYN M. ERNST

Department of Biology
George Mason University
Fairfax, Virginia 22030

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Accepted April 12, 1972

A Comparison of Populations of Boreal Red-backed Vole (*Clethrionomys gapperi*) in Tornado Blowdown and Standing Forest

Abstract. Comparison of *Clethrionomys gapperi* populations in tornado blowdown and standing forest were made one year after a tornado struck Basswood Lake, Lake County, Minnesota. Three times as many mice were captured in the blowdown areas as in the standing forest. Standing forest mice were more sexually active than blowdown mice. It is concluded that adult mice drive the juveniles into the blowdown.

In early August, 1969, a tornado blew down several acres of forest on Basswood Lake, Lake County, Minnesota. This report concerns the status of *Clethrionomys gapperi* (Boreal Red-backed Vole) on blowdown and standing forest during a study conducted on the mainland north of State Island between 4 and 16 August, 1970. The weather was hot and dry; temperatures ranged from a maximum of 97°F to a minimum of 54°F (the normal is 73°F to 51°F) and there was only ¼ inch of rain during the 13-day period.

Trap lines were run for three-day periods in three similar habitat pairs of blowdown and adjacent standing forest. Two trap lines of 40 four-inch Victor snap traps baited with peanut butter were placed in each habitat of a pair. All animals captured were measured for total, tail, hind foot, and ear lengths as described in Gunderson and Beer (1953) and sexed by dissection. Sexual activity was determined by descent of testes or presence of embryos or placental scars.

Forest composition was similar in the blowdown and the standing forest and west estimated by the point-central quarter method of Cottam and Curtis (1956) at 90-foot intervals. Estimates of percent trees fallen in the blowdown were made visually. Ground cover was estimated by taking m^2 plots at 200-foot intervals along the traplines in both habitats; estimates for percent of ground covered were made for less than two inches, two to ten inches, and over ten inches above the ground.

A Chi-square test was used to test the significance of the results. Blowdown and standing forest results were tested against an average over the two habitats.

Results

One hundred and eighty-one *C. gapperi* were captured in the blowdown (Table 1) and 51 in the standing forest (difference significant at the 0.01 level). A significantly higher percent (0.01 level) of the mice in the standing forest were sexually active. Standing forest animals also averaged larger.

TABLE 1. — Summary of *C. gapperi* Data

	Blowdown	Standing Forest
Number *C. gapperi* captured*	181	51
Number males	73 (43.5%**)	19 (38.0%**)
Number females	95 (56.5%**)	31 (62.0%**)
Number unidentified sex	13	1
Number sexually active males	16 (20.9%)	14 (73.7%)
Number sexually active females	22 (27.0%)	15 (48.7%)
Average number scars or embryos	5.3 (s=1.6)	5.9 (s=0.6)
Total number sexually active*	38 (22.6%**)	29 (58.0%**)
Average total length (mm)	124.2 (s=12.3)	127.8 (s=15.5)
Total number species captured	5	7
Total number animals captured of all species	187	67

*Difference significant at the 0.01 level.
**Percent of total *C. gapperi* of identified sex.

The forest composition and ground cover are summarized in Table 2 and Figure 1 respectively.

Discussion

Moist forest is the preferred habitat of *C. gapperi* (Burt, 1957; Burt and Grossenheider, 1952). If dominant mice drive young mice into the blowdown to maintain normal population levels in the standing forest, the blowdown populations will have a high proportion of sexually inactive, juvenile mice. The trapping results conform to this pattern. High population density might depress sexual activity in the blowdown. Calhoun (1962), however, found that high population densities of wild *Rattus norvegicus* did not affect sexual activity but affected maternal behavior and mortality rates. Calhoun also found that dominant *R. norvegicus* were able to maintain normal population densities within their territories despite population pressure from other areas. Saldeir (1965) found similar behavior in *Peromyscus maniculatus* which also support the hypothesis. The trapping results indicate that *C. gapperi* may be affected in a similar manner and that the low level of sexual activity in the blowdown mice is not caused by high populations but by a preponderance of juvenile mice.

Data on the number of embryos and placental scars per uterus in females show no significant differences between habitats. This does not contradict the hypothesis because litter sizes may not differ between habitats if population density does not affect sexual activity.

The large difference in *C. gapperi* populations between the two habitats clearly indicates a habitat preference, a behavioral response, or both. The most likely explanation at present is that the standing forest is preferred habitat for the species

TABLE 2. — Forest Composition Estimates

Tree	IV*	% Down in Blowdown
Paper Birch (*Betula papyrifera*)	0.919	57
Balsam Fir (*Abies balsamea*)	0.515	98
Aspen (Quaking and Bigtooth) (*Populus tremuloides*, *P. grandidentata*)	0.487	85
White Spruce (*Picea glauca*)	0.343	85
White Pine (*Pinus strobus*)	0.288	97
Red Pine (*Pinus resinosa*)	0.267	92
Basswood (*Tilia americana*)	0.051	
Ash (*Fraxinus* spp.)	0.047	
Red Maple (*Acer rubrum*)	0.031	
Bur Oak (*Quercus macrocarpa*)	0.023	
Mountain Maple (*Acer spicatum*)	0.014	
Jack Pine (*Panus banksiana*)	0.013	
Red Oak (*Quercus rubra*)	0.013	

*Importance Value (IV) = relative frequency + relative density + relative basal area.

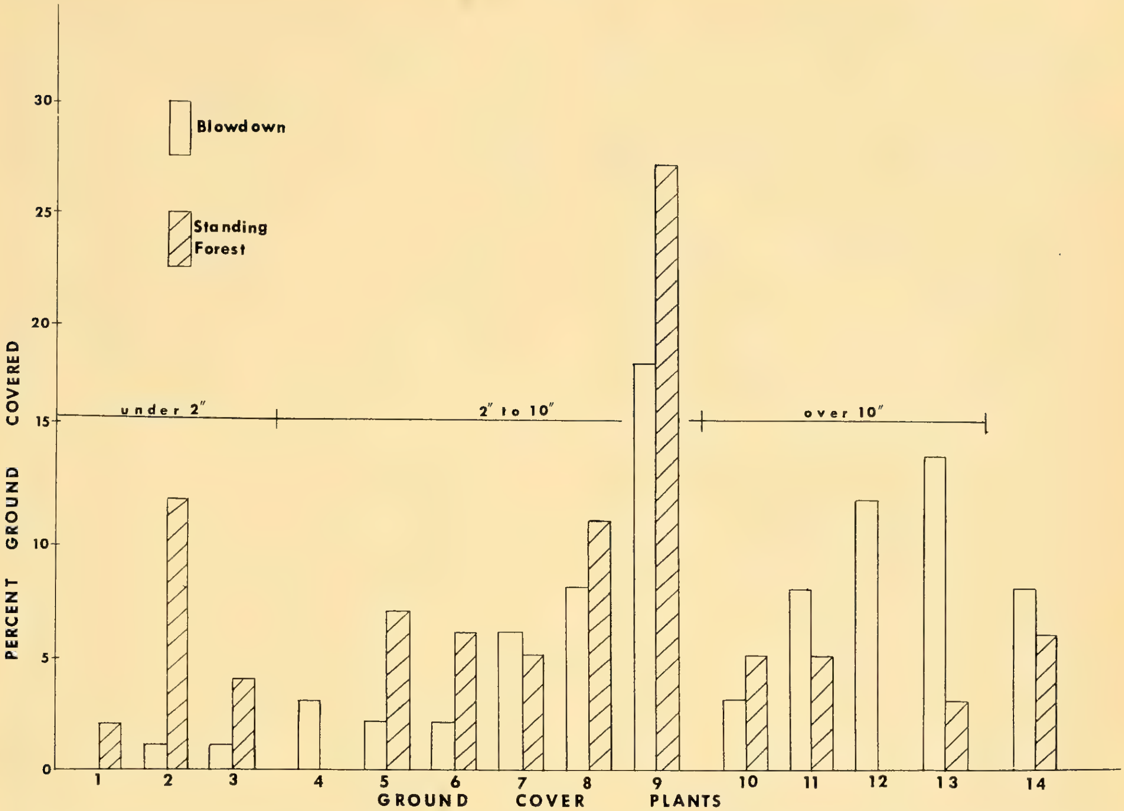

FIGURE 1. Ground Cover Estimates. The ground cover plants are 1-Lichens, 2-Mosses, 3-Ground Pine (*Lycopodium* spp.), 4-Horsetail (*Equisetum* spp.), 5-Blueberry (*Vaccinium angustifolium*), 6-Sarsaparilla (*Aralia nudicaulis*), 7-Bunchberry (*Cornus canadensis*), 8-Grasses (*Gramineae*), 9-Aster (*Aster macrophyllus*), 10-Bracken fern (*Pteridium aquilinum*), 11-Shrubs and seedlings, 12-Fallen green trees, 13-Raspberry (*Rubus strigosus*), 14-Miscellaneous.

and that the juveniles are driven into the less preferred blowdown.

Acknowledgements

I would like to thank Dr. William Brooks for advising me during the study and reading the manuscript, Dr. Paul Jensen, Dr. Dean Schneider, and Doyle McKey for reading the manuscript, and Sarah Miller for aiding in gathering vegetation data. A referee made helpful comments.

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ROGER A. POWELL

Department of Biology,
University of Chicago,
Chicago, Illinois 60637

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Accepted July 12, 1972

Black-necked Stilts Observed in Manitoba[1]

Abstract. Two observations of Black-necked Stilts are reported for Manitoba in 1969. Additional observations are summarized for the Northern Great Plains.

On 13 July 1969, Erik Carp of the Wildfowl Trust, Slimbridge, England and one of us (R.F.K.) discovered a Black-necked Stilt (*Himantopus mexicanus*) in a shallow, muddy pond at the University of Manitoba Field Station, near Delta, Manitoba. The bird was smaller in size than nearby American Avocets (*Recurvirostra americana*). Its bill was slightly upturned, the wings, back, top of head and back of neck were black, underparts were white, and in flight long thin red legs extended far behind its white tail. This observation was verified later the same evening by the senior author, T. O. Acere, Harold R. Bauer, and Donald J. Bernard. The senior author independently noted the same conspicuous form and colouration and the distinctive call. These observations were made in clear, almost still, warm weather through binoculars ranging from 7 x 35 to 10 x 50, at distances varying from 150 to 250 feet. By the time the diagnostic features were checked, the light was unsuitable for photographs, and subsequent attempts by Carp, Koes, McNicholl, and Dr. John F. Wright to find the bird were not successful.

A second Stilt observation was made by one of us (R.E.E.) at St. Ambroise, about 13 to 15 miles east of Delta on 9 August 1969, and verified later the same day by Mrs. England, and the following day by W. Douglas Kyle, of Winnipeg. The bird was observed under clear sunny conditions at a distance of about 80 feet, as it fed with a Greater Yellowlegs (*Totanus melanoleucus*) along a muddy shoreline. All field marks were carefully checked. One or both records were noted by Gardner (1969), Hatch (1969), Hosford (1969), and Mossop (1969).

These observations constitute the first verified site records for Manitoba. Lawrence (1929) and Taverner (1934:210) referred to doubtful reports from southwestern Manitoba, perhaps referring to Arnold's ambiguous list (1912). A set of purported Stilt eggs supposedly collected by Arnold in Saskatchewan (Bent, 1927:34; A.O.U., 1957: 209; Godfrey, 1966:166), is considered invalid (Godfrey, 1969).

The northern edge of the breeding range of this Stilt extends through southern Oregon, Idaho, northern Utah, southern Colorado, eastern New Mexico, the Gulf Coast of Texas, and southern Louisiana (A.O.U., 1957:209-210). Godfrey (1966:166) listed Canadian Stilt records for Newfoundland, New Brunswick, and Timmins, Ontario, but a number of sight records have been reported for Alberta and Saskatchewan. Salt and Wilk (1966:501) listed the species as hypothetical for Alberta, apparently on the basis of parts of a dead Stilt found near Brooks in the 1950's (Salt *fide* Weseloh, 1972). Weseloh (1972) obtained a recognizable photograph of one near Calgary on 12 May 1970. There are two unverified sight records for Saskatchewan. McLellan (1955) reported an observation of three on 20 May 1955, apparently at Arcola (pers. comm. C. S. Houston to M.K.M., 1971). Details given by him are very convincing (cf. Nero and Lein, 1971:31). D. H. Renaud observed a bird believed to be this species "under good light conditions although without binoculars" as close as 60 feet on 7 May 1971 at Rosetown (Houston, 1971a and pers. comm.).

North Dakota sightings include: one at Grafton, in the Red River Valley, spring of 1905 (Wood, 1923:28; Williams, 1926), one at Hankinson, 29 July 1921 (Lincoln, 1925:59; Bent, 1927:54), and sightings by Merril C. Hammond on the Lower Souris (now J. Clark Salyer) Refuge during 17-22 July 1946 listed in a check-list of North Dakota birds prepared by R. N. Randall. No details are available to support additional listings of the Stilt in a 1958 check-list of Long Lake Refuge and a 1962 check-list of Souris Loop Refuges (all R. E. Stewart pers. comm. to M.K.M.). South Dakota records include one near Waubay on 3 July 1949 (Chapman, 1949), one at Huron on 23 May 1959 (Krause, 1959:381), one near Long Lake, McPherson County seen by H. F. Duebbert and J. T. Lokemoen on 13 July 1971 (pers. comm. R. E. Stewart to M.K.M., 1971), and another reported at Roscoe on 13 July 1971 by Harold A. Kantrud (Houston, 1971b:870). These northern Great Plains sightings are mapped in Figure 1. Roberts (1932) recorded it as hypothetical for Minnesota on the basis of some early confusing records.

Acknowledgments

We would like to thank Dr. C. Stuart Houston and Dr. Robert E. Stewart for the information they supplied for this note; Dr. Timothy Myres and D. Vaughn Weseloh for making available the

FIGURE 1. Northern Great Plains records of the Black-necked Stilt. 1. Delta, Manitoba; 2. St. Ambroise, Manitoba; 3. Brooks, Alberta; 4. Langdon (Calgary area), Alberta; 5. Arcola, Saskatchewan; 6. Rosetown, Saskatchewan; 7. Grafton, North Dakota; 8. Hankinson, North Dakota; 9. J. Clark Salyer Refuge, North Dakota; 10. Waubay, South Dakota; 11. Huron, South Dakota; 12. Long Lake, South Dakota; 13. Roscoe, South Dakota.

latter's paper prior to publication; and Dr. Roger M. Evans and Dr. Robert W. Nero for critically reading the manuscript. The first observation was made at Delta when the senior author was studying there under a bursary from the National Research Council of Canada, with the support of N.R.C.C. grants to Dr. Roger M. Evans.

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MARTIN K. MCNICHOLL[2]
RAYMOND E. ENGLAND[3]
RUDOLF F. KOES[4]

Addendum: Since the above was written one additional Alberta record has been published. A Black-necked Stilt was observed at Irricana in the Calgary area by several reputable observers,

including Weseloh, on 24 May 1972, and further substantiated with photographs (Calgary Field Naturalist 4:11; American Birds 26:776). In addition, New Brunswick obtained its first sight record on 27 May 1972 (American Birds 26:739). -M.K.M., 27 September, 1972.

[1]Publication No. 16 of the University of Manitoba Field Station, Delta, Manitoba
[2]Department of Zoology
University of Manitoba
Winnipeg, Manitoba
(Present address: Department of Zoology
University of Alberta
Edmonton, Alberta)
[3]Department of Mines, Resources and Environmental Management
1301 Ellice Avenue
Winnipeg, Manitoba
[4]348 Oakwood Avenue
Winnipeg, Manitoba

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First Record of Chestnut-collared Longspur in Ontario

The Chestnut-collared Longspur, *Calcarius ornatus,* breeds from southern Alberta east to southern Manitoba, southeast of northeastern Colorado, northern Nebraska and southwestern Minnesota. It winters from Arizona, central Kansas, Texas, northern Louisiana and northwestern Mexico. (Godfrey, 1966). Migration appears to be a simple north or south movement depending on the season.

Examination of the literature reveals few records in northeastern North America, the ninth specimen for this region being taken in Connecticut in August 1968 (Bulmer, 1970). Eastern Canadian records are only three since the Grand Manan specimen on June 2, 1914 (Squires, 1952). These are of males and include the sight record Bon Portage I., N.S., May 29, 1962 (Bagg and Emery, 1962); specimen, Cape Sable, N.S., May 28, 1964 (Bagg and Emery, 1964); photograph, Ramea, Nfld., June 7, 1965 (Bagg and Emery, 1965). The extensive records of the National Museum of Natural Sciences, Ottawa (Godfrey, pers. comm.) and of the Royal Ontario Museum, Toronto, including those of the late J. L. Baillie (Goodwin, pers. comm.) give no indication of any sight records in Ontario. In view of the rarity of this species in eastern Canada and of no previous Ontario records, the observation of a male of this species on May 2, 1972 at Prince Edward Point, Prince Edward County, Ontario, (53°57′N, 76°54′W) is of interest.

The Chestnut-collared Longspur was first seen on the ground from our moving car at some distance, when the black on the breast and abdomen suggested a Dunlin, *Erolia alpina.* Closer examination with binoculars revealed that it was decidedly smaller than two adjacent Solitary Sandpipers, *Tringa solitaria.* A study from 15 meters, using a Bushnell 2OX wide angle telescope, showed a brilliant chestnut-coloured nape contrasting with the grey buff back. The head markings were striking, the white face being smartly outlined by the black top of the head and black eye line. The throat and cheek were tinged with buffy yellow. The solid black chest extended from below the throat to the anterior abdomen. The posterior abdomen was white. Vestiges of winter plumage could not be discerned.

The bird was bathing and feeding in short wet grass near a shallow farm pond. The bird disappeared before a photograph with a telephoto lens could be taken. It was neither seen flying away nor heard calling.

The bird was discovered during the course of the spring migration study carried out at Prince Edward Point daily between April 1 and May 31, 1972 by the Kingston Field Naturalists. The results of the spring 1971 study there were reported in this journal (Weir, 1972). The weather events of the 48 hours prior to the discovery of the longspur may be significant. On April 30, a depression centred in Colorado joined with a second depression in southern Saskatchewan. A very large high pressure area off the eastern U.S.A. coast controlled the weather from Mexico to New England, giving rise to a warm southerly air stream. The two depressions combined on May 1 to form a single major low over Iowa with a cold front extending to western Texas and with a maritime warm front over Illinois. It was this maritime warm air which influenced the weather at Prince Edward Point during the evening of May 1. Fog formed along the north shore of Lake Ontario. Visibility at the Point was reduced to 50 to 100 meters. Large numbers of migrating passerines where heard after sunset landing in trees along the south shore of the peninsula. Volume of migration increased until around mid-

night. Heavy rain after this made it impossible to hear the landing migrants. By dawn on May 2, the north shore of Lake Ontario from Kingston to a point east of Toronto was in a narrow band of warm maritime air sandwiched between two cold fronts. Seventy-five miles or so separated these two fronts, the southerly one of which bisected Lake Ontario. Arrested passerines at this time were everywhere in trees and on the ground, the night rains having emptied the skies. Drizzle ended around 0700 E.D.T. Presumably the Chestnut-collared Longspur was brought into our region by the eastward moving warm air mass with its southwesterly winds.

It may be significant that another western species was seen that day — two Oregon Juncos, *Junco oreganus*. The warm air mass had the effect of increasing species of passerines and individual numbers of species to a marked degree. Arrival dates of several vireos and warblers were the earliest ever for the Kingston-Prince Edward Point area.

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R. D. Weir[1]
H. Quilliam[2]
R. Norman[3]

[1]Department of Chemistry and Chemical Engineering
Royal Military College
Kingston, Ontario.
[2]R.R. 1
Kingston, Ontario.
[3]R.R. 8
Kingston, Ontario.

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Request for information: Sanderling

For the past two years, the Long Point Bird Observatory has undertaken a study on the relationship between fat deposition and fall migration in the Sanderling. In conjunction with this study, a large number of birds have been colour-marked and sightings of these marked birds away from Long Point have indicated that most of the birds fly directly from the study area to the East Coast.

During 1972, the Observatory hopes to individually colour-mark and colour-code several hundred Sanderling in order to further investigate this phenomenon. The colour-coding will involve three aspects: colour-marking with feather dye, wing-tagging and banding with the normal aluminum band.

Birds will be feather-dyed on the breast and abdomen with one of four colours: red, yellow, green, or white (no colour); according to the percent of the bird's total body weight attributable to fat.

The birds will be wing-tagged on *each* wing with semi-permanent wing tags of the following colours: black, blue, brown, green, red, orange, yellow and white. The wing-tagging will individually identify each bird.

The placement of the aluminum band will indicate the age of the bird. Birds banded on the right leg will be adults and those banded on the left leg will be immatures.

The Observatory would be pleased if anyone sighting these birds would report the following information to us:

Date of sighting

Location (including nearest city or town)

Colour of feather-dye on the breast and abdomen

Colour of the wing tag on the right wing

Colour of the wing tag on the left wing

Leg on which the bird is banded

Co-operators will receive a short note explaining the project's application to the preservation of the Long Point peninsula in a natural state and the date on which the bird was last seen on Long Point. Reports of marked birds should be sent to:

Long Point Bird Observatory,
Long Point, Ontario, Canada

Additional Information on Egg Shell Thickness in Relation to DDE Concentrations in Great Blue Heron Eggs

Vermeer and Reynolds (Can. Field-Nat. 84: 117-130, 1970) showed that shell thickness was inversely correlated with DDE residue levels in a sample of 40 eggs of Great Blue Herons, *Ardea herodias*, from Alberta. Comparisons on a wet, dry and lipid-weight basis revealed that the best correlation with shell thickness was obtained with the lipid-weight DDE concentrations ($r = -0.569$). The regression coefficient of the linear relationship between shell thickness and DDE concentrations was significantly different from zero ($p < 0.01$). Although the distribution of eggshell thickness data was approximately normal, the distribution of DDE residues within the sample was skewed towards the higher values. A logarithmic conversion failed to convert the distribution to normality ($\chi^2 = 9.63$, 3 df, $0.01 < p < 0.25$). Because of the skewed nature of this data, we have expanded the statistical language used to describe the relationship and here report the results.

Conversion of the data to their logarithms yields a better correlation between thickness and DDE residues ($r = -0.701$, log th. vs. log DDE; $r = -0.690$, th. vs. log DDE). Analysis of variance of the regression of log thickness on the log of DDE concentrations in lipid showed a significant

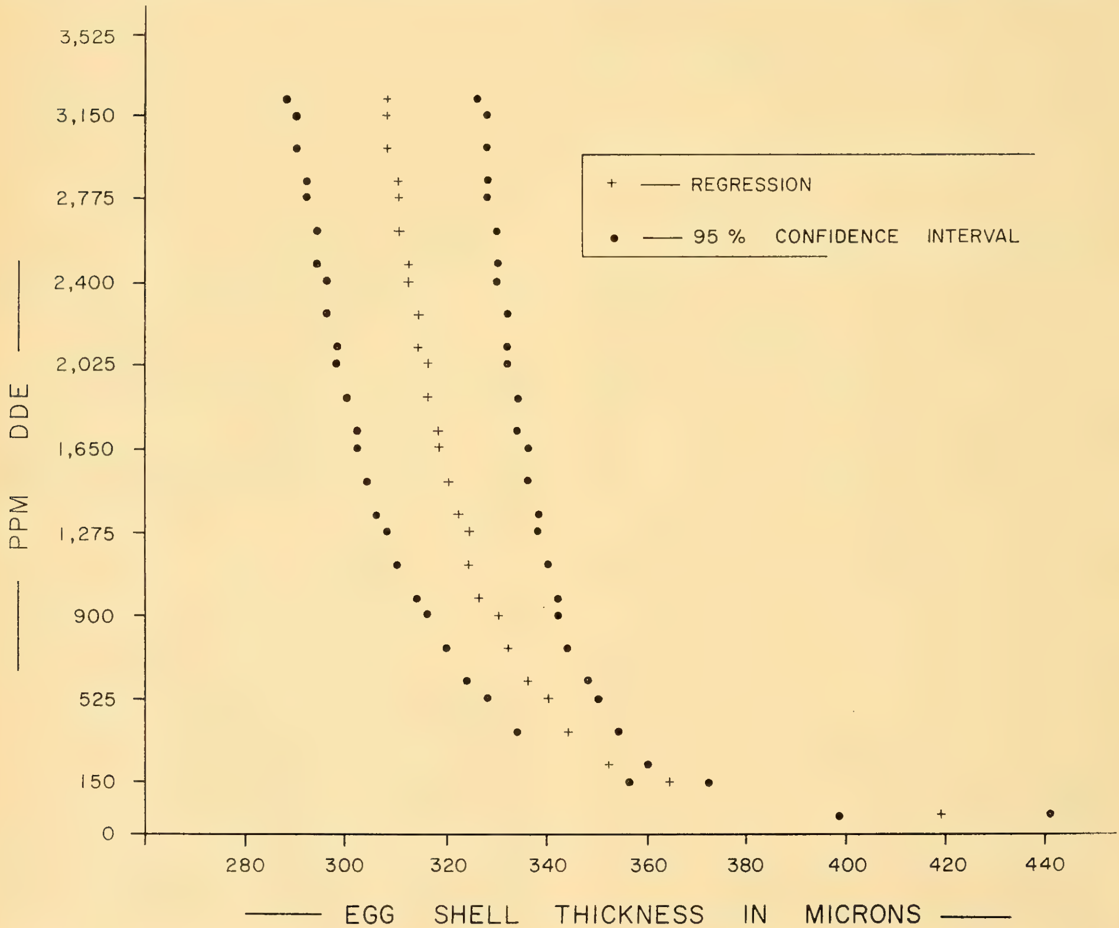

FIGURE 1. Relation between DDE concentrations and shell thickness in forty Great Blue Heron eggs from Albertan heronries in 1969.

TABLE 1. Spearman rank correlation coefficients, thickness versus pollutant concentration.

	DDE wet weight	DDE lipid	Dieldrin wet weight	Heptachlor epoxide wet weight
r_s	−.522	−.537	−.319	−.320
N	40	40	40	29
p	<.001	<.001	<.05	<.1

relationship ($F = 36.77$, 1,38 df, $p < 0.001$). A chi-square test indicated no significant deviation of the distribution of the residuals from normality ($\chi^2 = 3.25$, 4 df, $0.5 < p < 0.9$). Figure 1 shows the regression and the 95 per cent confidence intervals, calculated by computer, of the log of thickness on the log of DDE concentrations. The broadening of the 95 per cent confidence intervals with decreasing shell thickness and increasing DDE levels is most likely related to the small sample sizes in this region.

A non-parametric test that is independent of the distribution of the respective variables also shows a significant negative relationship between DDE and thickness (Table 1). The apparent relationship between dieldrin and thickness, considerably less significant than that of DDE, may be explained by the high correlation between dieldrin and DDE ($r_s = 0.63$, $p < 0.001$). The statistical significance is clearly not dependent upon the higher values of DDE, since either the two highest or the five highest values, wet weight basis, may be omitted without affecting significance ($r_s = -0.438$, $N = 38$, $p < 0.01$; $r_s = -0.396$, $N = 35$, $p < 0.02$). These treatments provide additional support, therefore, of the earlier conclusion that DDE is the cause of shell thinning in Great Blue Heron eggs.

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KEES VERMEER[1]
ROBERT W. RISEBROUGH[2]

[1]Canadian Wildlife Service, Edmonton
[2]Canadian Wildlife Service, Ottawa

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First Yellow Wagtail Nest Record for Canada

In the summer of 1972 considerable effort was put into gas pipeline impact studies in the Yukon Territory. As part of these studies a small camp was established on May 28 on the Babbage River by LGL Research Associates*.

At the camp location (latitude 68° 52′, longitude 138° 15′) the river runs east-west, and the camp was situated on the river's south side. Here the bank slopes up from the river at about 45 degrees to a height of 80 feet. There are willow trees 2 to 4 feet in height by the river and the remainder of the bank is tussock tundra.

Yellow Wagtails (*Motacilla flava*) were first seen near the camp on June 2. On June 17, on a walk along the river bank from the camp, east to a valley about one-half mile from the camp, and then along the valley side for one-half mile south, 6 pairs of wagtails were seen.

On June 24 a nest containing 5 eggs was found about 10 feet from the top of the river bank. The nest was made of grasses and was located in the northern side of a tussock. The bird and nest were photographed cinematically for Robin Gunn Ltd.** on July 1. The nest was visited on July 4, and the eggs were stil unhatched. On July 5 the nest was found torn out of the tussock and the eggs were gone.

Godfrey (1966) has given the status in Canada of the Yellow Wagtail: 'Found in summer in northern Yukon (near mouth of Firth River); probably breeds'.

In view of these remarks, the findings of the nest represents a first breeding record for Canada. Moreover, the Babbage River is roughly 30 miles east of the Firth River. It is quite possible that Yellow Wagtails may be found breeding even farther east, in a similar habitat, on river banks of the Yukon Territories.

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J. E. BLACK

Department of Physics,
Brock University,
St. Catharines, Ontario.

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*LGL Research Associates, 214 Merton Street, Toronto, Ontario.
**Robin Gunn Ltd., 214 Merton Street, Toronto, Ontario.

Additional Winter Records of the McKay's Bunting

McKay's Bunting (*Plectrophenax hyperboreus* Ridgway) is known from only a few specimens, most of which were taken during winter in southwestern continental Alaska (see Gabrielson and Lincoln, 1959). It has been collected in winter on Nunivak Island (Swarth, 1934), north to Nulato and St. Michael (Nelson, 1887) and south to Bethel (Stone, 1898), Nushagak (Osgood, 1904) and the Kuskokwim River (Grinnell, 1910). An individual was also collected on St. Paul Island of the Pribilof group on 30 March 1918 (Hanna, 1920). McKay's Buntings have been observed in winter at Mountain Village (Gabrielson and Lincoln, *op. cit.*) and during the spring migration at Hooper Bay (Brandt, 1943). Nelson (1887:182) alluded to a specimen of the McKay's Bunting taken on Unalaska I in January, 1879; however, it was not reported by Gabrielson and Lincoln (1959) nor did Ridgway (1884) refer to it when he described the species based on Nelson's specimens from St. Michael and C. L. McKay's from Nushagak. Murie (1959) cited Nelson's alleged record from Unalaska Island and stated that "Without doubt, this bird is quite common on Alaska Peninsula and the Aleutian Islands in winter."

Although the McKay's Bunting is considered by the A.O.U. Check-list (1957) to breed exclusively on Hall and St. Matthew islands, evidence for its breeding on St. Lawrence Island (Sealy, 1967, 1969) and on St. Paul Island (Kenyon and Phillips, 1965) has recently been obtained. The purpose of the present note is to record additional winter observations and specimens of this species, some of which extend its known winter range westward to the Seward Peninsula and southward to the Alaska Peninsula (Figure 1). Data from two specimens in the Museum of Vertebrate Zoology at the University of California (MVZ) and from three specimens in the University of Alaska Museum of Zoology (UA) were provided by Ned K. Johnson (*in litt.*, 1968) and Daniel D. Gibson (*in litt.*, 1972), respectively. I examined five specimens in the University of Michigan Museum of Zoology (UMMZ) and G. Vernon Byrd (*in litt.*, 1972) provided unpublished sight records contained in the files of the Aleutian Islands Wildlife Refuge at Cold Bay, Alaska. Two unsexed McKay's Buntings were taken by J.H. Turner on the Yukon [River?], Alaska, on 22 January (MVZ 8027) and 9 March 1891 (MVZ 8026). An early spring specimen of a male (UMMZ 166,527) was collected by H.C. Kyllingstad on 14 April 1944 at Mountain Village. Also in the UMMZ are four specimens taken near Nome by J.A. von der Heydt: one male (no. 116,415) was collected on 29 March 1948 and two males and one female (nos. 135,862-4) were taken there on 27 March 1954. More recently, three adult male McKay's Buntings (UA 3131, 3132, 3240) were collected at Nome on 18 February 1970 by G.E. Hall (Gibson, *in litt.*, 1972), not 17 February 1970 as inadvertently reported by Gibson (1970).

Foster (1970) stated that "Although McKay's Bunting has been recorded as far north in western Alaska as St. Lawrence Island and St. Michael, there were no [published] Seward Peninsula records prior to this winter [1969-1970]. At least a few were present with Snow Buntings [*P. nivalis* (Linnaeus)] early in that period at the Nome dump." Foster observed eight on 29 December 1969 and 20+ McKay's and at least 20 Snow Buntings there in March, 1970; Hall (1970) observed about 10 to 15 McKay's in a flock of about 50 *Plectrophenax* buntings near Nome on 17

FIGURE 1. Localities of wintering and breeding in the McKay's Bunting.

February 1970. Foster (1971) stated that "For the second winter in a row McKay's Buntings over-wintered on the beach at Nome. Four were seen there on Dec. 28, 1970 . . . and they had been there for some time." McKay's Buntings were first recorded on an Alaskan Christmas Bird Count when R.D. Jones saw one individual (with a flock of Snow Buntings) twice on 2 January 1966 at Cold Bay (Jones, 1966). There are a few subsequent records from Cold Bay. A female was captured and banded and one male was seen by E.P. Bailey on 6 February 1970. One was seen feeding with Gray-crowned Rosy Finches (*Leucosticte tephrocotis*) and Snow Buntings on 29 January 1971 by Margaret Smith and a male banded on 1 February 1971 by Bailey was recaptured several times until 5 February. G.V. Byrd saw one female on 15 December 1971 and banded a second which was recaptured almost daily from 11 to 22 January 1972 by Byrd and Bailey. From 1 to 8 February they observed up to two males and one female foraging at the bait traps near the Wildlife Refuge Office. Remarks by Byrd concerning these latest observations are of interest; he stated (*in litt.*, 1972) that "A male [McKay's Bunting] was watched at the feeder. He found a pile of grain outside the traps and defended it against the Snow Buntings and rosy finches, being the last to fly at a disturbance. He was a very aggressive feeder." On 2 February two males and one female were near the traps but not captured; "One male was completely surrounded by a circle of Snow Buntings which kept closing around him until he decided they were too close. He stopped feeding and spread the birds out again."

The presence of overwintering McKay's Buntings at Nome and the migratory patterns of Snow Buntings in Alaska, although complex and poorly known (see Irving, 1960), may account for the occurrences of McKay's Buntings in summer on St. Lawrence Island, some 190 km southwest of Nome and 320 km north of its usual nesting areas on Hall and St. Matthew islands. It appears that McKay's Buntings leave Hall and St. Matthew islands in early October (see Swarth, 1934; Gabrielson and Lincoln, 1959) and fly eastward to Nunivak Island and contintental Alaska where they apparently spread out to the north and south, possibly following the coastline and/or interior rivers with a few individuals reaching Nome. Since McKay's Buntings are frequently encountered in flocks of Snow Buntings in winter, it is possible that some individuals stray to the Snow Bunting breeding areas in spring with such flocks. Snow Buntings do not winter in large numbers on St. Lawrence Island and the bulk of the breeding population arrives there in early May (Fay and Cade, 1959), probably from the Seward Peninsula and points east in North America because only the nominate race *nivalis*, which does not penetrate Siberia in winter, breeds on St. Lawrence Island (Gabrielson and Lincoln, 1959; Vaurie, 1959).

I would like to thank G. Vernon Byrd, Daniel D. Gibson, and Ned K. Johnson for providing details of observations and specimens of McKay's Bunting. Robert W. Storer kindly provided access to specimens under his care in the University of Michigan Museum of Zoology.

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SPENCER G. SEALY

Museum of Zoology, University of Michigan,
Ann Arbor, Michigan.
Present Address:
Department of Zoology, University of Manitoba,
Winnipeg, Manitoba R3T 2N2

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Sabine's Gull Sightings in Alberta

On June 3, 1972, at Beaverhill Lake (40 miles east of Edmonton) a single adult Sabine's Gull, *Xema sabini,* was observed for 15 minutes at close range by D. Dekker and myself. This bird was very active and seemed nervous. It did not associate with nearby Franklin's and Bonaparte's Gulls. Shortly after this individual flew off, we saw a flock of about 40 adult Sabine's Gulls heading northward. Single adults have also been seen: at Lake Wabamun (40 miles west of Edmonton) by L. Noton on May 30, 1972, and near Kirkpatrick Lake (15 miles south of Coronation) by Wm. Glasgow on June 30, 1972. These sightings add weight to the possibility of Sabine's Gulls migrating regularly through Alberta.

PHILIP S. TAYLOR

Department of Zoology,
University of Alberta,
Edmonton, Alberta.

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Sabine's Gulls in Alberta

On June 3, 1971, during a survey of birds on Cooking Lake (15 miles southeast of Edmonton, Alberta), a small flock of Sabine's Gulls (*Xema sabini*) was seen by A. Garbutt, T. Neraasen, and myself. Three of the birds, all adult females, were collected and placed in the University of Alberta Museum of Zoology (Nos. 4105-4107). This unusual sighting led me to inquire about the general frequency of inland records of this species.

The breeding range of Sabine's Gulls is circumpolar, centered in the Bering Sea vicinity (Bent, 1921, p. 191). Godfrey (1966, pp. 187-188) states that the "Winter range (is) poorly known but includes coastal Peru", and that outside the breeding season they occur in "mostly coastal waters, rarely on southern interior fresh water . . . Rare migrant in the Canadian interior but recorded in Alberta, Saskatchewan, Manitoba, Ontario, and Quebec".

Published records of this species in Alberta are very few, and the locations of sightings include Baptiste Lake, Muriel Lake, Sullivan Lake, Calgary, Beaverhill Lake (Salt and Wilk, 1966), and Lake Athabasca (Höhn, 1970). Unpublished sightings in Jasper National Park by M. Hampson and R. Richards (pers. comm.) are listed below:

June 13, 1968 (M.H.) — one adult at Lake Mildred.
June 28, 1968 (R.R.) — two adults with Bonaparte's Gulls (*Larus philadelphia*) at Lake Edith.
———— 1969 (R.R.) — two adults at Lake Edith and one at Lake Mildred.
July 4, 1970 (R.R.) — two adults on the Athabasca River.

Mr. Richards, a resident of Jasper, was not in Alberta during most of the summer of 1971. Also he has never seen any Sabine's Gulls in the fall months. The only fall record of which I am aware was at Beaverhill Lake, where four (both adults and juveniles) were seen and one collected in late September, 1929 (W. Rowan, unpubl. field notes; Salt and Wilk, 1966). Although I do not know the dates of some of the sightings in Alberta, it appears that Sabine's Gulls are seen more often in the early summer months (June-July) than in the fall.

We should be aware of the possibility that Sabine's Gulls migrate regularly through Alberta, although they undoubtedly use the oceans and

coasts as their main habitats and routes. On June 9, 1959, the remains of two adults were found on the shore of a lake near Cold Lake, Alberta (Salt and Wilk, 1966); this discovery suggests that large numbers passed through Cold Lake, at least in 1959.

I believe that any large flock of black-headed gulls should be carefully scrutinized for the presence of a few Sabine's Gulls. The small number (at least 10 and probably 25 or more) of Sabine's Gulls that we observed were far from shore on the open water, in the midst of thousands of Bonaparte's Gulls. Still the Sabine's Gulls were maintaining their own small flock within the larger horde. Although this species is easily identified at long range, its superficial resemblance in plumage and voice to Bonaparte's Gulls makes the presence of small numbers of Sabine's Gulls difficult to detect.

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JAMES W. WOLFORD

Department of Zoology,
University of Alberta,
Edmonton, Alberta

Spring Observations of Sabine's Gull

In view of the comparatively sparse information of the movements of Sabine's Gull (*Xema sabini*) away from its breeding grounds, two spring observations may be worth putting on record. On 6 June 1957 about 30 individuals of this species were seen at a shoal north of Masset Spit, Graham Island, Queen Charlotte Islands, B.C. Distance, spray from waves breaking on the shoal, and the presence of Glaucous-winged Gulls (*Larus glaucescens*) hindered detailed observations, but adults appeared to predominate. On 29 May 1967, while eastbound on S.S. *Empress of England*, my wife and I saw an adult Sabine's Gull pass close to the ship heading due north as closely as I could judge. The ship's position at the time was ca. 54°N 45°W, i.e. some 400 miles south of Cape Farewell.

D. B. O. SAVILE

Plant Research Institute,
Central Experimental Farm,
Ottawa, Ontario. K1A 0C6

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Evidence of Tree Nesting by the Marbled Murrelet in the Queen Charlotte Islands

Harris (1971, Can. Field Nat. 85: 67) has given new evidence of tree nesting by the Marbled Murrelet (*Brachyramphus marmoratum*) in Vancouver Island. There is also strong indirect evidence of this behavior in the Queen Charlotte Islands.

In 1957, during botanical field work with J.A. Calder and R.L. Taylor, from late May to mid August, I noted that this species was particularly abundant near Masset and in the eastern part of Masset Inlet. (Place names are conveniently located from Figure 1 of Calder and Taylor, 1968, Flora of the Queen Charlotte Islands, part 1, Canada Dept. of Agriculture Monograph 4.) The adjacent land in the Eastern Lowlands is clothed in tall coniferous forest. The species was less abundant in the western part of Skidegate Channel, off the west coast from Skidegate Channel and Empire Anchorage, and in the central part of Masset Inlet; and none were seen in the western part of Masset Inlet. Thus the population seems to drop off markedly in waters adjoining the Skidegate Plateau and the Queen Charlotte Range, where there is an abundance of cliffs and scrub forest that might be expected to attract alcids.

The most significant observation was made on 17 July, while we were returning from Langara

Island to Masset on the Fisheries vessel *Biltmore*. Many alcids were flushed from the calm water near the north coast of Graham Island. At least two of various Marbled Murrelets that were flushed were carrying several small fish crosswise in the bill. They flew directly toward the shore rising to near tree-top height before being lost in haze at a distance of a mile or more. The observation strongly suggests that these birds had young in the tall conifers of the lowland forest, and regular abundance in the area suggests that the region west of the entrance to Masset Inlet may support a substantial breeding population. Securing specimens from such a site would be extremely difficult. It should be possible to follow birds from the feeding area by helicopter, and to drop colored markers to guide a ground party, but the size of the trees and the markedly cryptic coloring of the birds' plumage against a background of conifer twigs will make nest detection very difficult.

D. B. O. SAVILE

Plant Research Institute,
Central Experimental Farm,
Ottawa, Ontario. K1A 0C6

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Wolverine in Gatineau Park, Quebec

A wolverine (*Gulo luscus*) was sighted at the base of the Eardley Escarpment about 0.5 km west of the Luskville Falls lookout (45°33N', 76°02'W), Pontiac County, Quebec on March 25, 1972. R.E. Curiston, the pilot of a Hiller 12-E helicopter, and I were carrying out an aerial survey of white-tailed deer (*Odocoileus virginianus*) wintering within the Gatineau Park. At about 1520 hr we were flying westward along the southern boundary of the park at the base of the escarpment when two deer ran onto a snow covered field about 0.5 km ahead of us. The field was bordered by the forested escarpment on the north and a stand of trees that ran from the escarpment along a creek drainage on the east and south. The two deer ran some 50 m into the field, stopped, and looked back at the hillside. This behaviour was unusual, as normally disturbed deer flee for heavier cover. Also it was unlikely that the helicopter had disturbed them at that distance. As we approached from the east, we observed a third animal in the field on the trail of the deer. It turned and retreated toward the escarpment. We identified it as a wolverine from its bear-like loping action, long hair, and the orange colour on the flanks that continued onto the rump. We turned about and hovered some 40 m away from the fleeing wolverine. The wolverine stopped running, curled itself in a ball, and faced the helicopter. On several occasions I saw wolverines assume this defense posture in response to approaching aircraft in northern Manitoba. We then landed, and the wolverine escaped up the escarpment. Its tracks measured 115 mm long by 85 mm wide.

The two deer that the wolverine had apparently been following were back-tracked about 170 m. Their tracks indicated that they had come down the escarpment and onto the edge of the field at a fast pace followed by the wolverine. It is not known whether or not the wolverine was in pursuit of the deer at the time. Perhaps the deer happened on the wolverine as they descended the escarpment, and the wolverine being an opportunist, followed them. Although Gatineau Park is within the former range of the wolverine in Eastern Canada, its occurrence in southern Quebec is now rare (Peterson, R.L. 1966. The Mammals of Eastern Canada. Oxford University Press. Toronto. 465 pp.).

FRANK L. MILLER

Canadian Wildlife Service,
Eastern Region, 2721 Highway 31,
Ottawa, Ontario. K1A 0W1.

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Accepted September 27, 1972

Western Records of the Chestnut-sided Warbler

On 31 May 1972 an adult male Chestnut-sided Warbler, *Dendroica pensylvanica*, was found dead beneath a window at the Edmonton home of Mr. and Mrs. A. Blades, members of the Edmonton Bird Club. Thanks to their recognition that it was a rarity the specimen reached my hands and was preserved. It is deposited in the collection of the

Provincial Museum and Archives of Alberta as the first specimen obtained in Alberta.

During the last few years I have spent considerable time checking the source of unusual Warbler songs in Alberta. On 15 June 1972 I heard two songs which could be fitted to the words, *very, very, pleased to meetcha.* The songsters were about a quarter of a mile apart along a woodland road 9 miles south of Thosby, Alberta, and about 3 miles north of Pigeon Lake. One of the birds eluded me completely in an extensive thicket of tall willows. The other sang in aspen trees apparently without moving for I was unable to spot it until a Philadelphia Vireo, *Vireo philadelphicus,* chased it into view. It was a male Chestnut-sided Warbler. The bird was collected and proved to be in full breeding condition. I was never able to corroborate visually my identification of the second bird. In the light of my limited experience with this species in eastern Canada the type of habitat selected by the Chestnut-sided Warbler was unexpected. It was in mature aspen forest about seventy yards from the road. The undergrowth of willow, alder, and red osier dogwood was neither dense nor high as I moved about in it freely for twenty minutes circling a group of three aspen from which the song came. If a female was within ten or fifteen yards of these trees she would probably have been disturbed. Other avian occupants of the area, in addition to the Philadelphia Vireo, were a Mourning Warbler, *Oporornis philadelphia,* which sang close by and, farther back in the woods, an Ovenbird, *Seiurus aurocapillus,* and another Mourning Warbler.

Prior to 1972 there had been only sight records of the Chestnut-sided Warbler in Alberta. Bent (1953) says a specimen was taken at Red Deer but he gives no authority for this statement and I can find no other reference to such a specimen. Cole (1939) reports that a small flock of warblers spent the morning in spruce trees at Red Deer in late August 1938. In identifying these as Chestnut-sided Warblers she writes, "No other bird in Taverner's Birds of Western Canada fitted the description". T. E. Randall observed Chestnut-sided Warblers near Boyle on 20 May 1934 and on 4 July 1934 found a nest containing young (Salt and Wilk 1958). In 1935 he reported five Chestnut-sided Warblers near Fawcett early in May. When I requested further information in 1970 about these observations he referred briefly to both in his letters but said he could give no additional details of either because his field notes had been lost in the course of much moving about. However, he wrote that while at Tupper Creek, B.C. in 1944, he found this species quite plentiful and, "found two nests with four and five eggs, on July 4th". Tupper Creek is in British Columbia about 20 miles south of Pouce Coupe and only a few miles west of the Alberta border. This report would extend the breeding range of the Chestnut-sided Warbler some 300 miles farther west and a little farther north than his previous nesting record at Boyle, Alberta.

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W. Ray Salt

Department of Anatomy,
University of Alberta,
Edmonton, Alberta.

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Success of Three Gull Species Feeding on Swarming Ants in Antigonish County, Nova Scotia

On 6 September 1971 I observed a flock of gulls hawking after swarming ants from 16:00 to 18:00, at which time I ceased observation. The swarm was located above an uncut hay field and also over the brackish waters of the adjacent harbour. The flock varied in number from seven to 20 adult and immature Bonaparte's Gulls (*Larus philadelphia*), 10 to 20 adult and immature Ring-billed Gulls (*L. delawarenis*) and one adult Herring Gull (*L. argentatus*) which never left the flock. Several species of gulls, including the above, are known to hawk after insects. Tufts (1961) noted that Herring Gulls have been observed hawking, possibly after ants, in Nova Scotia and

Harlow (1971) reported several non-gull species feeding on swarming ants in Maine.

The three species enjoyed a measure of success in catching the prey; however the Bonaparte's Gulls were 90-100 per cent successful as they picked ants from the air with forward thrusts of the bill. The Herring Gull was successful on less than 50 per cent of thrusts. No score was recorded for the Ring-billed Gulls, but they had more success than the Herring Gull and less success than the Bonaparte's Gulls. Immature and adult Bonaparte's Gulls were equally successful. Bonaparte's Gulls made more thrusts per unit time than either of the other two species. It appears from the observations that there is a marked difference in hawking efficiency among these gulls with the smallest and most manoeuverable flyer, the Bonaparte's Gull, being most successful at this method of feeding.

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NORMAN R. SEYMOUR

Department of Biology,
Saint Francis Xavier University,
Antigonish, Nova Scotia.

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RALPH DURHAM BIRD, 1901-1972

C. D. Bird

Department of Biology, University of Calgary,
Calgary, Alberta

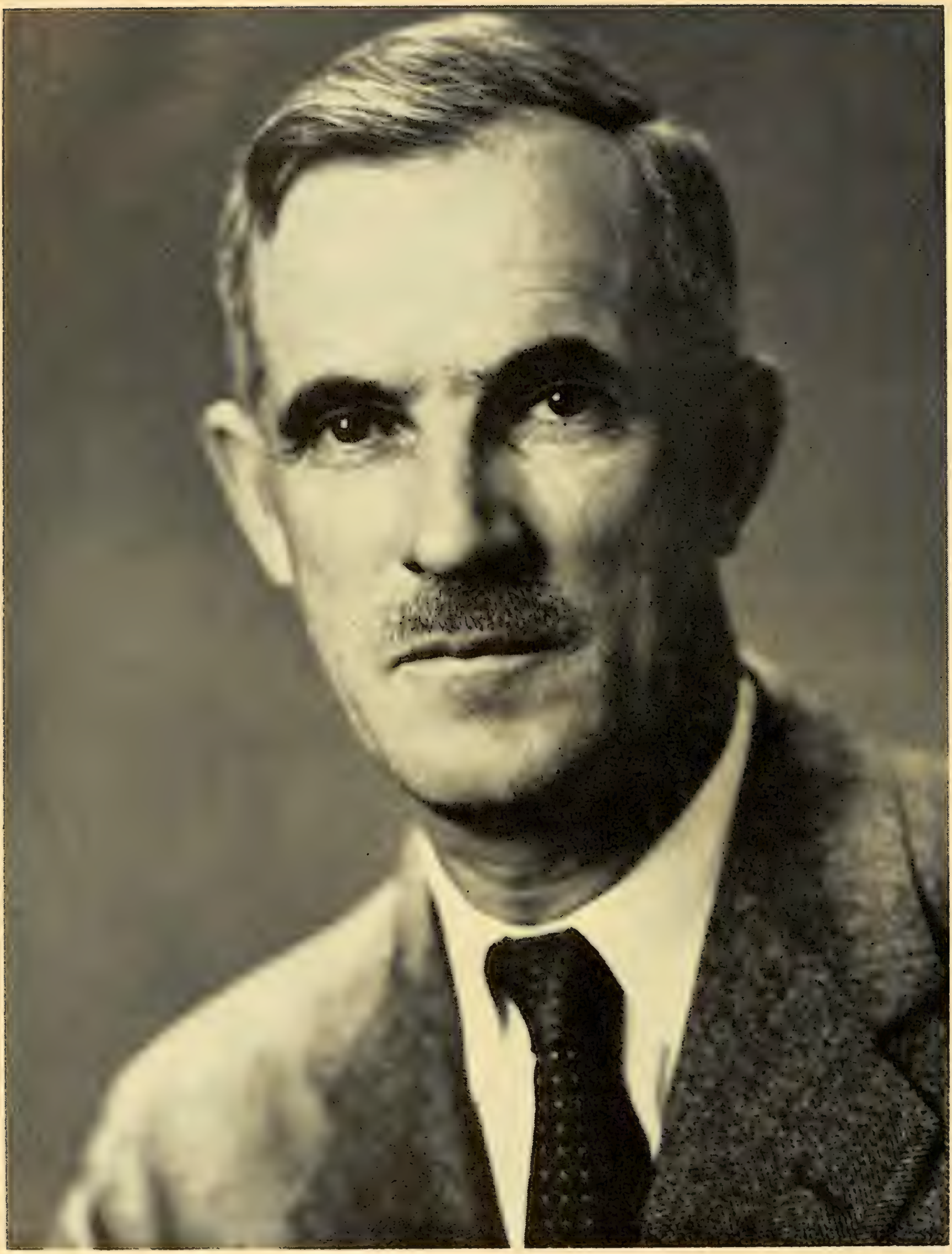
On March 1, 1972, at the age of 70, Ralph Bird passed away suddenly of a coronary thrombosis on Saltspring Island, British Columbia. This event came as a real shock to those who knew him as he was mentally alert, physically vigorous, and was active in many things. A keen field naturalist, he was born, brought up, and worked in the aspen parkland of west-central Canada, leaving there only at the time of his retirement.

Born at Arrow River, Manitoba, on May 20, 1901, the son of Arthur Durham and Ethel (Winter) Bird, Ralph Bird took early schooling at the nearby Blenheim and Thoona Schools, and then moved to Birtle where he attended high school. He then moved to Winnipeg and commenced study at the University of Manitoba where he specialized in Botany, Zoology and Entomology. He obtained a B.Sc. in 1924 and a M.Sc. in 1926. He later remembered with much fondness the summer research he was involved with during this period. In 1923 he was Student Assistant with a Geological Survey of Canada field party led by M. Y. Williams along the Milk River, Alberta. In the summers of 1924, 1925 and 1926 he was Junior Entomologist for the Canada Department of Agriculture working at Aweme, near Treesbank, Manitoba, under the direction of the pioneer naturalist Norman Criddle. He obtained a Ph.D. in 1929 from the University of Illinois where his supervisor was V. E. Shelford, a major proponent of the new "experimental ecology". His published thesis "Biotic communities of the aspen parkland of central Canada" was accepted as the authoritative work on the ecology of the area and served as the basis for numerous subsequent studies. During the summer of 1927 he studied at the Puget Sound Biological Station on San Juan Island, Washington, a time he remembered with such pleasure that it no doubt influenced him in choosing Saltspring Island, less than 50 miles away, as his place of retirement.

Dr. Bird taught at the University of Oklahoma from 1929 to 1933. He carried out summer research on Entomology with the Oklahoma Biological Survey. A diplopod, *Eurymerodesmus birdi* Chamberlin, and two flies, *Saropogon birdi* Curran and *Psilocurus birdi* Curran, that he found during this work were later named in his honor.

In 1929 he married Lois Hazel Gould, the daughter of Dr. Charles Newton Gould, head of the Oklahoma Geological Survey. Lois had a B.Sc. in Botany from the University of Oklahoma and had published weekly columns on the local flora in the Daily Oklahoman and two papers on blooming dates of spring flowers. Her knowledge of plants assisted him greatly in his later research.

He carried out research on fruit insects and grasshoppers with the Canada Department of Agriculture at Vernon and Hat Creek, B.C., in the summers of 1931, 1932 and 1933. In the fall of 1933 he became Officer-in-charge of the Federal Entomology Laboratory in Manitoba following the death of Norman Criddle. The Lab was moved from Aweme to Brandon late in 1933 and Dr. Bird served as its Head until 1957. Studies at the Brandon Lab from 1933 to 1942 were primarily on grasshoppers. Research after 1942 was enlarged to include studies on insects feeding on oil seeds, small fruit, vegetables and forage crops. In 1957 the Brandon Lab was closed and its staff transferred to Winnipeg to become part of the newly-formed Canada Department of Agricul-



ture Research Station. Dr. Bird became Head of its Entomology Section and later, in 1963, Head of its Crop Protection Section. He remained in the latter position until his retirement in 1966.

His wife, Lois, died of cancer in January 1959. Shortly thereafter he took a three month trip to Africa, especially Kenya and Uganda. In the fall of that year he married Lilian Mary Watson. Lilian was a commercial artist who had worked for many years with Brigdens of Winnipeg and who had studied at the Winnipeg School of Art under L. L. Fitzgerald, one of "The Group of Seven".

Upon retirement in the spring of 1966 he moved to a country home with seashore frontage near Ganges on Saltspring Island where he immediately became absorbed in photography, gardening and nature study. He became active in various local natural history and conservation groups, consulting on pollution problems, lecturing to the Vancouver Natural History Society, promoting the study of local flora and fauna and pointing out the need for hiking trails and more park area on the Island. He was preparing to act as an Instructor in a Hunter Training Course at the time of his death.

A keen photographer, Dr. Bird worked initially with black and white. He entered Salon Prints in world wide competitions and received many awards of merit. He established a reputation as an insect photographer, wrote articles on this subject, and his photographs were sought by many authors to illustrate publications concerned with insects. He later turned to color and gave many lectures illustrated by slides to various scientific and natural history groups.

Ralph Bird's publications are extensive and cover a wide range of topics. The central focus of his work was ecological. He was particularly interested in those changes in the fauna and flora which resulted from agricultural activity. His monograph "Ecology of the Aspen Parkland in Western Canada in relation to land use" which appeared in 1961 was a major contribution in this area. Fascinated by archaeology, Dr. Bird carried out, in consultation with R. MacNeish of the National Museum of Canada, special investigations at the Stott Site near Brandon. In 1964 he published, with L.B. Smith, the results of three years of research on the economic status of the Red-winged Blackbird in Manitoba. This was a basic study of the food habits of the species which can do considerable damage to cereal crops and sunflowers. In 1967 he started research with his son on the lichens of Saltspring Island. This study culminated in a paper soon to appear in the journal Syesis. In 1971 he produced a manuscript list of 331 vascular plant species he knew to occur on Saltspring Island. Most of these he had either collected, photographed or observed. This was the start of a projected flora of the vascular plants of the Island.

Dr. Bird developed an interest in taxidermy before he left the farm at Arrow River and he continued this hobby until 1957 when he moved to Winnipeg. He particularly liked to work with big game heads and for a number of years was an official recorder for the Boone and Crocket Club.

A keen hunter all of his life, he was an excellent shot. He liked nothing better than a day in a marsh or in the woods. He loved the out-of-doors and everything that was in it. He felt that hunting was a part of nature and that, with the disappearance of natural predators, it was necessary that man take their place. He made a point to never exceed his limit or break the regulations as he was a firm believer in wildlife management.

Active in many groups having to do with the promotion of wise land use policies and ecology, he held membership in various Committees including the National Committee on Pesticide Use in Agriculture, the Manitoba Grasshopper Control Committee, the Manitoba Museum Association Committee and the Manitoba Game Advisory Committee. He was Chairman of the "International Great Plains Conference of Entomologists" from 1956-58, was President of the Natural History Society of Manitoba from 1960-61 and was President of the Entomological Society of Manitoba from 1964-

65. Various honors bestowed upon him include being made a Charter Member of the Manitoba Institute of Agrologists in 1951, an Honorary Life Member of the Brandon Game and Fish Association in 1957, a member of the Scientific Club of Greater Winnipeg in 1957, an Honorary Life Member of the Natural History Society of Manitoba in 1966, an Honorary Life Member of the Manitoba Federation of Game and Fish Associations in 1966 and an Honorary Member of the Entomological Society of Canada in 1970.

Ralph Bird is survived by his wife Lilian, of Ganges; a son, Dr. C. D. Bird of Calgary; two daughters, Mrs. J.A. (Maida) Neilson of Winnipeg and Mrs. J.F. (Linda) Young of Ottawa; and by 9 grandchildren.

Acknowledgements

Special thanks are extended to the following people for their help: Mrs. Lilian Bird, my wife Ann, Mr. and Mrs. J.F. Young, Mrs. Maida Neilson, Dr. L.B. Smith, Mr. I.C. Shank and Dr. W.R. Allen.

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News and Comment

Some New Ventures

During the summer Ted Mosquin requested that he be relieved of his duties as editor of *The Canadian Field-Naturalist*. The request, although not entirely unexpected due to Ted's involvement with the newly formed Canadian Nature Federation and their magazine *Nature Canada,* was received with regret. As editor, Ted implemented many physical and philosophical changes in *The Canadian Field-Naturalist*. These ventures have been of a most positive nature. The energetic dedication of Editor Mosquin has certainly enlivened the journal, raised the already high standards set for authors, and has resulted in a strengthening of several areas of coverage. These accomplishments were not without their frustrations nor without the investment of a significant number of hours. In print a simple "thank you" hardly seems to express our feelings but we are sure Ted knows the sincerity behind those woods.

The appointment of Dr. Lorraine Smith of Carleton University as our new editor was unanimously approved at the September 11th council meeting of the Ottawa Field-Naturalists' Club. Your Journal is in good hands.

In a different vein, the Ottawa Field-Naturalists' Club earlier this year applied to the National Research Council's Committee on Grants to Research Publications for financial support to aid in the publication of *The Canadian Field-Naturalist.* Of primary concern in making the application were our increasing costs, the need for expansion of each issue and the need to continue our financial support of manuscripts by persons unable to meet the page and other charges generally assigned to authors. The National Research Council awarded the journal a grant for one year and we thank the Grants to Research Publications Committee for their consideration.

Finally a word about an old friend. This issue contains fewer pages than originally planned because our printer, Runge Press, is in the process of moving into a new plant. Subsequent issues of this journal will be produced by the off-set method of reproduction. The staff of *The Canadian Field-Naturalist* wishes all the people at Runge Press the very best in their new venture.

JAMES H. GINNS,
Chairman, Publications Committee

Proposed Organization for Bird Population Studies

Stephen Fretwell, of Kansas State University, has proposed an institute to study theoretical and analytical aspects of bird populations and their regulation. He hopes to finance this work, and the popularization of bird population studies, through individual subscriptions by interested bird enthusiasts across the continent. This method of financing has been used by the British Trust for Ornithology, but the proposed sphere of activity is more comparable to that of a university research team; the B.T.O., like the Migratory Bird Populations sections of the Canadian Wildlife Service and the United States Fish and Wildlife Service, is concerned with the large-scale collection of bird population data first, analysis of these data second, and theorizing a distant third.

Theoretical research on bird populations is needed. And many bird watchers have money which could profitably be spent in supporting such an institute. There will be major problems in persuading the public that they should individually support such work, rather than leaving it to the government or to the universities. And the people and organizations which collect the data may prefer to analyse their material themselves. There are some advantages to having this work done by a privately financed research organization, which can allocate its funds where they are needed at the critical moment. For rare or threatened species, the time lag in government and university financing could be critical. For further information, contact:

Dr. Stephen Fretwell,
Division of Biology,
Kansas State University,
Manhattan, Kansas 66502, U.S.A.

Book Reviews

This Good, Good Earth: Our Fight for Survival

By Ralph O. Brinkhurst and Donald A. Chant. Macmillan Co. of Canada, Toronto. 174 p. $2.95.

The authors rightly believe that public apathy is a major force for bad environmental management. They were striving for a better environment long before that activity became popular. They are aware of the special privileges and responsibilities of academics in the fight for a better environment. As a mark of their responsibility they have written a book which explains the facts behind many of the present environmental problems. It points out clearly why some of the problems arose and how, with presently-available technology, many of them can be solved; this is if we really want them solved and are willing to take the effort and accept the cost. In all cases rapid improvement requires decisive action. Although some action of that kind has been brought about by confrontation, the authors believe that, in the long view, other methods will be more effective. They say "pressure groups will become passé as society awakens and our governments progress from the fighting of local pollution crises to the long-term business of national quality management. Confrontation tactics may indeed be necessary in the future to prevent flagging of the purpose and to keep the system honest, but anti-pollution groups will interrelate more and more with decision-making centres in government and industry".

Several of the authors' other statements are worthy of frequent repetition. Some examples follow:

"The polluters claim that they cannot afford to clean up without losing markets, that the cost would be too high and too disruptive of the economy. Similar excuses were once given in defense of slavery, child labour, and the frightful working conditions and housing of the early Industrial Revolution Complexes in Europe."

"What absolute lunacy it is to allow oceans of sewage to destroy our desperately needed water supplies while at the same time we manufacture artificial fertilizers so expensive that many farmers can no longer make a decent living. This insanity is compounded by the fact that our fertilizer factories are among our worst polluters".

"What would happen to a single family that spent so much money on an automobile and a big house that it could not pay the water and heating bills? Yet our towns and cities claim that financial considerations preclude them from carrying out one of their primary duties — that of proper waste disposal. What restraints have they — and we — put upon the huge expenditures for jamborees like Canada's Expo and the coming Olympics (which will be held in a city that lies in the middle of a river full of faeces)?".

"All our economic theory excludes the hidden cost of our activities, the cost charged to the environment, the great unpaid bills. Of course the reclamation of Toronto's sewers in a couple of years would put an intolerable burden on the city's finances, unless serious sacrifices were made, but the city has not built a major interceptor sewer since 1917. During fifty years of fantastic growth the cost has been borne by Lake Ontario. If we had known what the cost of using the Lake as a dump really was, we could have entered that into our accounts, and we would have seen the steady rise in the debit column as time and growth increased the burden. We prefer to think that our politicians would have acted sooner if this information had been shown to them as a dollars-and-cents debit item. Instead, the cost was reflected in closed beaches, decreased fish yields . . ."

This is a belligerent book. It is a book both for those who are already concerned and for those who must become concerned about why our tax dollars are not always used to improve the only environment we have now or ever will have.

V. E. F. Solman

Canadian Wildlife Service
Ottawa, Canada
K1A 0W1

The Naturalists' Directory

By Willard H. Baetzner. PCL Publications, Box 583 South Orange, N.J. 07079. 1972. 178 p. $7.50 cloth, $5.00 paper. 41st edition.

This book gives the names, addresses and specialities of world naturalists, as well the addresses of associations, societies and organizations (in-

cluding museums) dealing with natural history. Material is treated alphabetically within geographical regions. The final section of the text lists natural history publications. I have not discovered any section which approaches complete coverage and all sections contain some errors of fact. Both of these faults are probably a result of the method of information gathering — strictly on a volunteer basis. Despite its shortcomings the directory is very useful, and if interested parties report errors or omissions the publisher will be able to provide a more useful compendium. If naturalists are unhappy with this edition, it is up to them to supply information to improve the next one.

CHARLES G. GRUCHY

Ichthyological Unit,
National Museum of Natural Sciences,
Ottawa, Canada K1A 0M8

The Mutagenicity of Pesticides

By S. S. Epstein and M. S. Legator. 1971. The MIT Press, Cambridge, Mass., London, England. XVII + 220 p. $12.50.

For several decades, studies have shown that certain herbicides, fungicides, and insecticides cause chromosome breakage and produce gene mutations similar to those produced by irradiation. It has been observed that the hereditary constitution of both plants and animals may be altered as a result of pesticide treatment. The development of insect resistance is well known and subtle changes have been noted in the flora as the result of widespread spraying. Within the last few years pesticides have been shown to present a potential danger to the germ plasm of man.

If one possesses the *Report of the Secretary's Commission on Pesticides and their Relationship to Environmental Health* (U.S. Department of Health, Education, and Welfare) published in 1969, then *The Mutagenicity of Pesticides* by Epstein and Legator is immediately a disappointment in that there has been no up-dating of information. The text of the book is a brief 69 pages. Appendix Table 1 (105 pages) comprises the main portion of the book and lists some 370 pesticides by their common names and synonyms, their chemical names and formulae, their major uses, manufacturers, and a list of cross references. It is perhaps this table for which the publishers designed the unwieldy shape of the book (height 142 mm, width 210 mm). Appendix Table 2 is a review of the literature on the mutagenicity of pesticides. This table lists only 33 pesticides which shows how few have been studied for their mutagenic properties. Appendix 3 is a "Bibliography on Mutagenic and Related Effects of Pesticides and Related Compounds" and consists of 404 references. This bibliography includes references to chemosterilants, growth retardants and carcinogenic compounds.

The need to test for the mutagenicity of pesticides is pointed out in the elegant "Foreword" to the book by Lederberg in which he states that 25% of our health burden is of genetic origin and that "this figure is a very conservative estimate in view of the genetic component of such griefs as schizophrenia, diabetes, atherosclerosis, mental retardation, early senility, and many congenital malformations". Among other points of interest emphasized by Lederberg are 1) the need for a quantitative standard of chemical mutation rate similar to the 10% increase in existing *spontaneous* mutation rate which has been adopted as the *maximum acceptable* level of exposure to radiation and 2) that the responsibility for safety-testing be in the hands of disinterested third parties, and be funded by fees taxed to the sponsors of pesticides.

Since this text is the first treatment of the mutagenicity of pesticides, it will serve as the standard reference on this subject for some years to come. At the same time, the rapid accumulation of new data in this field is likely to require a revision in the foreseeable future.

WILLIAM F. GRANT

Genetics Laboratory,
Macdonald Campus of McGill University,
Ste. Anne de Bellevue,
Quebec, Canada

Ecology, Pollution, Environment

By A. Turk, J. Turk and J. T. Wittes. W. B. Saunders Co., Philadelphia, London, Toronto. 1972. 217 p., illus. $4.10.

The book begins with a short course in basic ecology which includes man in his place in the system. This is followed by a review of agriculture and its uses and misuses. A chapter is devoted to pesticides and the long term problems they cause

as well as the short term solutions they provide. Radioactive wastes have a chapter themselves as do air pollution and water pollution. Solid wastes from source to recycling are well dealt with as are human population growth, thermal pollution and noise.

Each of the 10 chapters follows the same format. A good explanation of the situation is followed by a series of problems. Answers are given to the few mathematical problems but not to the many philosophical ones. Each chapter has a good bibliography.

The photographs, charts and drawings are well reproduced and aptly chosen. The 4 cartoons make their points very forcibly.

The text gives a good broad perspective on all three subjects in the title. It is easy to read and provides much information that every taxpayer should have. If, in addition to reading and understanding the text the reader can also provide good answers to the problems (all 105 of them) he should enter politics. We need such well informed citizens to make the political decisions that will maintain a pleasant, safe and stimulating environment for our future.

V. E. F. SOLMAN

Canadian Wildlife Service
Ottawa, Canada
K1A 0W1

Beyond the Land Itself: Views of Nature in Canada and the United States

By Marcia B. Kline. Harvard University Press, Cambridge, Mass. 1970. 75 p. $2.00 paper.

This book is an essay in literature, not an essay in natural history. Its author seeks to explore "the differing attitudes toward the natural world that could arise from two intially similar situations." The two similar situations in this context are the confrontations of two young nations, the United States and English-Canada, with wilderness North America. The attitudes under consideration are those reflected in a small sampling of literature from both countries during the nineteenth century.

In general, the author concludes from her comparisons that Americans, having cut themselves off from the old world by revolution, were ripe for favorable response to the freedom of the hills. Canadians, on the other hand, remained loyal to the old order, fearing the wilderness and "repudiating all that was non-English about Canada." They longed for the more pastoral nature of their homeland.

I suspect that there is some validity to this analysis, although I would question whether the comparisons which have been made are completely "fair." The "balmiest" parts of Canada are north of the northernmost extremes of the United States' lower 48, and we might expect that, under pure pioneer conditions, our literary people lived in a harsher, less loveable environment than was the case across the border.

Further, as the author admits, there was not much Canadian literature to draw from (again, perhaps partly because Canadians were too busy surviving to write). Different individual backgrounds probably contributed as much to authors' attitudes as did national feelings. At one point, for instance, Canadian writer Susanna Moodie is quoted as follows:

> *Fancy would starve for lack of marvellous food to keep her alive in the backwoods. We have neither fay nor fairy, ghost nor bogle, satyr nor wood nymph; our very forests disdain to shelter dryad or hymadryad.*

At the risk of being labelled unromantic, I suggest that an actual discovery of any one of these critters in woods anywhere, even in England, would constitute a significant range extension. The quote does not reflect a "view of nature." Rather, it is a failure to view nature. Scores of naturalists, including a burgeoning proportion from America, now flock to Canada's backwoods, and there they find sufficient raw material to keep their fancies amply fed.

In reading this book, I couldn't help wondering whether any conclusions were warranted for modern attitudes toward nature in the two countries. Considering the present overcrowded, neonized, and polluted state of much of the continental United States, it is hard to believe that it is a manifestation of love and zeal for the land. As the saying goes, "with friends like that, who needs enemies?" And, if Canadian nature attitudes have indeed sprung from a background of discontent and fear, I shudder for the future of our wilderness.

DAVID F. HATLER

Dept. of Zoology
Univ. of British Columbia
Vancouver 8, B.C.

Biometeorological Methods

By R. E. Munn. Academic Press, New York. 1970. 336 p. $17.50.

True to the chosen title, *Biometeorological Methods* surveys *how* biometeorological studies may be conducted rather than *what* past studies have reported. Results from some past studies are presented but only as examples of methodology. These examples are well chosen and vary widely from the use of hospital admittance records to the measurement of water temperatures in the tropical Atlantic Ocean. Because this is a single volume only, it cannot contain sufficient detail on each technique discussed to be considered a handbook on biometeorological methods. The reader will find here a rich source of ideas on techniques, the details of which may be pursued through the extensive bibliography included in the book.

Chapter one briefly defines the subject to be discussed. "Biometeorology is that part of physiology and of ecology in which the atmosphere is a significant environmental factor" (P. 2). The reader is alerted that the scope of the subject is very wide.

Chapters two to four are mainly concerned with experimental design. Important problems involved in sampling through time are discussed such as handling data taken at fixed time intervals, matching sampling rates to sensor response times and the danger of inferring the time averaged effect of two or more variables acting simultaneously from a knowledge of only the average of each variable. The expression of radio-activity and pollutant dosages is covered and various applications of the degree day concept are cited. Fitting mathematical expressions to time dependent biological functions is also mentioned in this section, and although the computer simulation approach to certain biometeorological problems is briefly discussed in other chapters as well, in my opinion the power of these methods could have received more emphasis in this book. Spatial sampling problems such as network design and extrapolation between observation points are next discussed; the use of visual observations, questionnaires and routine climatological data is surveyed; and the methods, merits and pitfalls of controlled environment studies are very well summarized.

Having now obtained the necessary data, how are they best analyzed, understood and displayed? Chapters five through nine seek to answer these questions. A smattering of graphical techniques is first presented, then follow about forty pages on statistical methods. Some of these pages demand more than the "knowledge of elementary statistics" suggested in the Preface, but this section is quite self-contained so if the reader is not able to cope with the mathematics here, he can skim through without endanging his comprehension of the remainder of the book. One of the most important points made in this section is that "multivariate analyses should only be used if no other method is available" due to the usual "failure of the method to provide any physical understanding of the nature of a relation" (P. 122). The powerful dimensional analysis technique and its application to modelling begins chapter eight, then the very useful concepts of water and energy budgets are introduced with practical applications of the latter to problems such as wind chill and heat stress appearing in chapter nine.

Biological phenomina related to continental scale (synoptic) weather features are descriptively treated in the next chapter. These include the synoptic situations favourable to dangerous air pollution episodes and the transport of spores, insects and birds by the wind.

Solutions to the difficult but critically important problem of estimating evapotranspiration rates from climatological data are presented in chapter ten. These lead to estimates of soil moisture and hence to methods of predicting agricultural yield.

As the book nears its end, climates of the past and future are discussed along with various indices which may be computed from climatological data. Studies of tree rings and pollen as indicators of paleoclimate are mentioned. Computer simulations of future climate and simulations of man's likely influence on that future are dealt with, but rather briefly. The use of weather indices is illustrated with examples from the fields of air pollution, agriculture, and human comfort. I was disappointed by the omission of any examples of agricultural pest prediction indices computed from weather observations because this is an area of personal interest. The final chapter, *Engineering and economic applications*, contains a very fine summary of some meteorological-economic techniques that may used in decision-making from meteorological data.

In summary, *Biometeorological Methods* is an excellent dictionary of techniques. The reader benefits from the author's ability to read prolifically and to synthesize literature from a wide variety of disciplines into a coherent story. Anyone in-

terested in the atmospheric environment will find it a useful source of ideas and a useful starting point for literature searches.

T. J. GILLESPIE,

Agrometeorology,
University of Guelph.
Guelph, Ontario.

Studies of Bird Hazards to Aircraft

By Canadian Wildlife Service, Report Series Number 14, Ottawa. 1971. 105 pp. Price $1.25.

This report is another example of the excellent work being done by the Canadian Associate Committee on Bird Hazards to Aircraft. Topics include: habitat management and bird harassment techniques useful for reducing bird hazards at airports, a radar technique for determining the numbers and height of night migrants, and details of some types of bird movements revealed by radar.

Seven papers are presented: Solman — Bird control and air safety; Gunn and Solman — A bird-warning system for aircraft in flight; Myres and Cannings — A Canada Goose migration through the southern interior of British Columbia; Richardson and Gunn — Radar observations of bird movements in east-central Alberta; Speirs, Kanvitz, and Novak — Numbers, speeds, and directions of migrating geese from analysis of a radar display at Fort Williams, Ontario; Blokpoel — The M33C track radar (3-cm) as a tool to study height and density of bird migration; and Blokpoel — A preliminary study on height and density of natural fall migration.

The first two papers are excellent resumes of the overall problem in Canada and remedial measures that are practiced or have been suggested. Solman states that human motivation is the biggest need in the continuing battle to keep birds out of the way of aircraft, and I wholeheartedly agree. The important point is made that the major hazard from migrating birds is caused by mass movements of birds gull-sized or larger and occurs in rather limited times and locations. The authors believe, and have demonstrated that forecasting of major spring and autumn movements is possible within certain limits, that radar surveillance permits detection of bird flights, and that this information can be used effectively in flight planning and in air traffic control to reduce significantly the number of bird strikes.

The remaining papers present the results of radar studies of bird movements in various Canadian locales. Speed, heights, and densities of migrating birds, and the effects of weather on migration are reported.

This publication is a necessary addition to the library of those concerned with the world-wide problem of bird-hazards to aircraft. Overall, it is of excellent quality and is relatively free from typographical errors. Unfortunately, the Perspectives gives the impression that 160 lives have been lost in the U.S. due to bird-aircraft collisions since 1960. Actually, the total is about 90.

JOHN L. SEUBERT

U.S. Bureau of Sport Fisheries and Wildlife
Patuxent Wildlife Research Center
Laurel, Maryland 20810 USA.

A Tourist Guide to Mount McKinley

By Bradford Washburn. Alaska Northwest Publishing Company, Box 4 — EEE, Anchorage, Alaska 99503. 1971. 79 p. $4.50 paper, $7.75 cloth.

The book is in three parts. After a dedication, foreword and table of contents, pages 10 to 24 describes Mount McKinley, the highest mountain in North America in excellent prose and 21 superb photographs, two of them full page. Washburn's 29-year love affair with the mountain comes out clearly. It is easy to share his great enthusiasm.

Pages 25 to 52 inclusive give a very attractive mileage guide to the 91.25 mile Denali highway leading from the entrance to Mt. McKinley National Park across the north part of the park to an area just outside the park where there is a landing strip from which flights to view the mountain could be made. The end papers of the book (hard cover) provide a good map of the park and the road. The road description includes notes on viewpoints, details of plants and animals likely to be seen and includes 49 colour plates (one a two-page spread) of flora, fauna and scenery as well as a list of campground facilities and locations. The text, which is attractively written would be really helpful to anyone driving the road and not wanting to miss any points of interest.

Pages 53 to 75 inclusive record the history of the discovery of the mountain and its climbing history from first ascent in 1913 to the 89th in 1970. That section is illustrated with 24 black

and white and 6 colour photographs. A bibliography (2 pages), an index (1 page) and a day length/season diagram (1 page) complete the book.

Although two-thirds of the book is devoted to the mountain and mountain climbing, the remainder will be very useful for a non-climbing visitor to the park. Since Mt. McKinley is the highest mountain in North America it is impossible to consider the park without the mountain or the mountain without its history and its ascents. The book is well written, carefully produced and excellently illustrated. With dimensions of 8½ × 11¼ and a hard cover it is not a pocket book but rather with its wrap-around colour print cover more of a coffee table conversation piece.

V. E. F. SOLMAN

Canadian Wildlife Service,
Ottawa, Canada K1A 0W1

The Family Life of Birds

By Hans D. Dossenbach. McGraw-Hill Book Company. New York. 1971. 192 p. $9.00. Available in Canada from Ryerson Press/McGraw-Hill, Canada, Scarborough, Ont.

Most bird books are written by ornithologists, or at least by people who know a good deal about birds. In the case of "The Family Life of Birds", this apparently was not so. It was conceived and designed by a director of a publishing company, it was illustrated by an army of commercial artists, translated by a professional translator and finally prepared for publication with the help of an American consultant, a scientific advisor, a production assistant and an editor. Yet in spite of this impressive array of technical experts (or perhaps because of it) the book is extraordinarily bad.

Hans Dossenbach, who is credited as being the author, is a talented and resourceful wildlife photographer. Some of his pictures, like the one of the titmouse family on page 147, are absolutely superb. His series of photographs of eggs and nests on pages 96-97 and of nestlings on pages 154-155 are not only excellent examples of the photographer's art but they are of considerable scientific value in that they illustrate stages in the life history of many species which are frequently neglected by outdoor photographers. Some of his other photographs however, are somewhat inferior. Some, like those on pages 41 and 117 have actually been retouched; surely a questionable practice even for a semi-popular publication. Another criticism of the photography, and this is not so much the fault of the photographer as of the editor, is that in some cases far too many pictures have been used. For example there are no fewer than fourteen illustrations of the same peacock, many of them in the same pose and seven of the same pair of albatrosses. Unfortunately the captions accompanying the photographs frequently bear little relationship to the subject in the picture. At least two of the illustrations (those on pages 172 and 184) have no captions what-so-ever and the birds in another five photographs are incorrectly identified.

As for the text, it is difficult to ascertain the authorship of much of it. There are at least three recognizable writing styles and the quality ranges from very bad to very good. Some parts of it are excessively anthropomorphic (e.g. the accounts of courtship behaviour on pages 50, 120 and 136) and much of it is simply inaccurate or unscientific. In contrast to these passages, there are some which are remarkably well written and completely accurate in their factual details. I refer for example to the excellent chapter on nest parasitism in cuckoos and to an equally thorough account of the breeding biology of the Guanay cormorant. A cynical reader might guess that these particular passages had been taken from some other book, but since there are no references cited, there is no way of knowing. Part of the problem may of course be due to faulty translation. Fritz Bauchwitz, generally speaking, has done a commendable job of rendering the text into English but he consistently uses the word brood in place of breed (the same error is repeated ten times) and he apparently cannot differentiate between a swamp and a marsh. The American consultant, Bertel Bruun, should have picked up these mistakes.

The line drawings, charts and sketches of various sorts are, like the text and photographs, very uneven in their quality. Some of the better illustrations have been reproduced from other publications, with due acknowledgement (e.g. Gould's "Birds of Britain" and "Birds of Europe"); some have been redrawn from other sources, without acknowledgement (e.g. Huxley's "The Courtship habits of the great crested grebe"), while others have been blatantly plagiarized (e.g.

the lithograph of the Purple Heron on page 28). This confusion of artistic styles only adds to the heterogenous appearance of the book.

Unquestionably the most conspicuous fault of this book is that it is totally disorganized and for this I hold the designer, Emil M. Bührer responsible. If you examine the table of contents (which incidentally is on the second last page) you will find that there is a section dealing with mating customs in the middle of a chapter entitled "The Rocky Bird Isle in the North"; there are two different sections dealing with bird nurseries; the chapter on courting customs, comes after the chapter on nest building and what is even more puzzling, the chapter entitled "Wives, Sweethearts, Concubines" has been inserted between "Birds and their Eggs" and "The Bird Family". The designer presumably is also responsible for the format. While the layout is attractive in an artistic sense, it tends at times to become rather confusing for the reader when there are photographs, line drawings and three styles of script all on the same page (c.f. p. 130). The elaborate index on pages 186-191 is so fraught with mistakes as to make it quite useless.

Not withstanding its many shortcomings, "The Family Life of Birds" is an attractive looking book and I expect that many people will buy it without examining it very closely. I have no doubt but that the publisher will be well rewarded for his investment of money and manpower.

C. M. YOUNG

Department of Biology
Laurentian University
Sudbury, Ontario.

Blue Meridian — The Search for the Great White Shark

By Peter Matthiessen. Random House of Canada Ltd., Toronto. 1971. 204 p. $10.75.

Normally, books of this sort are not reviewed in these columns, for this is neither a book for the specialist, nor is it in one sense, a "natural history" book. *Blue Meridian* is the written account of the production of the film "Blue Water, White Death" and it deals with the search for the great white shark, *Carcharodon carcharias*, in the waters near Southern Africa, Ceylon, and Australia. To my mind it summarizes more accurately the frustrations, tensions, and problems of a marine expedition than anything else I have recently read. It does provide some information — as well as speculation — on the natural history of several species of sharks and it also provides some insight into the South African whaling industry. The colour photographs are excellent and one only regrets that more were not included.

It is frustrating for an ichthyologist to read that the expedition made no attempt to capture an unusual shark off South Africa. However, it is disturbing to read "Another thing shark authorities agree on is that sharks should never be provoked, but *probably the exact opposite is true*" (p. 55) [Italics mine]. It seems foolish, if not irresponsible to make such a statement, for it might cause inexperienced divers to attack every shark they see. Sharks have every advantage over humans in the water, and to avoid them is to avoid trouble. On the other hand, if a shark attack is imminent, one has nothing to lose by trying every available means to ward it off.

I agree with the author that "turtle-riding" and fish-feeding antics are disgusting, if not demeaning to the animals involved. But I cannot agree that Prince Edward Island is part of New Brunswick (p. 112).

On the whole the book is interesting for the observations it makes on shark behavior and it is immensely readable. This book presents excellent insight into a marine expedition, but unfortunately it may be passed over in the virtual plethora of recent books on sharks.

CHARLES G. GRUCHY

Ichthyological Unit,
National Museum of Natural Sciences,
Ottawa, Canada K1A 0M8

Kamloops, an Angler's Study of the Kamloops Trout

By Steve Raymond. Winchester Press, New York. 1971. 218 p., text-figures, photos, 2 colour plates. $14.50.

A book of this genre can be written either by a scientist with breadth of vision and skill in popular writing or by a dedicated angler with skill in writing who will delve into the scientific literature. The scientist is frequently not fluent in communicating with the public using the pen. If a civil servant, he cannot give free discourse on

topics such as pollution or government support of his work.

The author, a journalist and angler, is free from these problems that a scientist would encounter. On the other hand he has had to tackle the scientific literature, search, decipher and interpret it. Generally speaking he manages to correctly convey the main principles of fisheries management and ecology of the Kamloops trout. His layman status does occasionally show, as for example in his spelling of caudle for caudal, *Cottus cognaturs* for *Cottus cognatus*, usage of the genus *Aplites* instead of *Micropterus*. Dr. E. J. Crossman has his initials changed to D. J. The table on contiguous species will be of little use in fish identification.

There are chapters in the book on history of the fish, the life cycle, the environment, management, tackle, fishing techniques, and recommended waters. Perhaps his most important contribution is in the bringing together of information on fishing fly patterns. Old patterns, such as Carey's and Nation's are described as well as new ones contributed by the author.

The writing is generally clear and pleasant. It will be an easy introduction to the ways of the Kamloops trout for the angler or naturalist, although for authoritative information on scientific aspects he may wish to go to other sources.

The book is reproduced on matte natural colour paper with wide margins in a shibui binding.

DON E. MCALLISTER

Curator of Fishes,
National Museum of Natural Sciences,
Ottawa, Ontario K1A 0M8

Seaweeds of Cape Cod and the Islands

By John M. Kingsbury. The Chatham Press Inc., Chatham, Massachusetts. 1969. x + 212 pp., 114 figs., $12.50.

In scope and, to some degree, intent this book is comparable to that of Muriel L. Guberlet's "Seaweeds at Ebb Tide", University of Washington Press, 1956, which is also a popular treatment of the benthic marine algae, but dealing with species of the temperate west coast of North America. They resemble each other a great deal in the presentation of descriptions and comments, in the line drawings, and even in format, whereby a species is discussed on one page, and conveniently illustrated (gross habit) on the opposing page. The outstanding difference is price. Guberlet's book, which unlike Kingsbury's is paperbound, could be bought for $2.95.

Some 93 species, all of which as the title would probably indicate are attached, multicellular forms, are discussed in varying detail as to their habitat, structure, and life histories. To avoid technical terminology as much as possible, it is written in a narrative and commentarial style. Unfortunately, for a group of organisms as complex as the algae, this kind of presentation promotes for the most part an oversimplified judgement on the differences between one species and another. But as the author had apparently intended, the book is primarily one of illustrations which the collector can refer to for the identification of Cape Cod algae. Although the discussion sections have limited practical application towards the sorting of the different species occurring in the Cape Cod region, they are effective in providing a readable, nontechnical account of the algae.

R. K. S. LEE

Phycology Section
National Museum of Natural Sciences
Ottawa, Canada K1A 0M8

Mountain Sheep: A Study in Behaviour and Evolution

By Valerius Geist. University of Chicago Press, Chicago. 1971. 383 p. $14.50.

The book *Mountain Sheep* is much more than just a book on *Ovis canadensis* and *Ovis dalli*. It is also a declaration of the author's fascinating theories about the evolutionary forces that shaped the social behavior of large Pleistocene mammals. Mountain sheep are used as a foundation for his theses. However, many aspects of mountain sheep life are thoroughly discussed by Dr. Geist, and the discussions are based partly on the rich fund of knowledge he gathered during nearly four years of field research on the two species of mountain sheep in Canada.

The book is one of a series on wildlife behavior and ecology edited by Dr. George Schaller of the New York Zoological Society. It is organized into a dozen chapters dealing with data collection methods, and with home ranges and movements, social organization and behavior, and the dynamics

of several populations of mountain sheep. The first eleven chapters lead up to the presentation of Dr. Geist's theories about the influence of glaciations on the evolution of behavior and morphology of mountain sheep. The introductions to each chapter are simplified abstracts of the chapter's contents and are therefore useful references. Although the book is illustrated with excellent photographs and drawings by Dr. Geist, which in themselves are worthy of study, maps of sheep movements would have been a helpful supplement to the text. Some of the graphs illustrating statements in the text would have been more useful had sample sizes been indicated. Some comments in the text should have been accompanied by source citations.

The book is apparently aimed at an audience having a good background in zoogeography, in taxonomy, and in genetics as it applies to the evolution of species. Wildlife management biologists may have to review fundamentals of mammalian ecology and keep Dobzhansky handy if they are to understand the text fully. The description of the book's contents on the dust jacket states that amateur naturalists are part of the intended audience. Although some parts of the book indeed might make fascinating reading for the amateur, I would steer the layman toward less complex publications about the life history of mountain sheep.

Dr Geist writes like he thinks and talks. He has a brilliant and agile mind capable of developing and exploring theories in rapid-fire order. When he speaks, you are enthralled and you leave with your mind charged with a variety of new ideas. He is intense and entertaining — and so is his book. The volume of information in the book causes one to marvel at how one man could arrive at so many conclusions and propose so many hypotheses after less than four years of field work.

The book cannot be read once lightly — it must be studied carefully and perhaps read again. Dr. Geist suggests reading the introductory chapter and the concluding chapter first. After having tried both the conventional progression and Dr. Geist's suggestion, I recommend that the reader follow the author's advice, if only to imprint in his mind the hypotheses and conclusions which the complex discussions in the remaining chapters elaborate.

The major weakness of the opus is that it progresses through such a tangled web of well documented conclusions and unverified statements that it confuses the reader and he begins to wonder which Dr. Geist believes to be facts and which are merely hypotheses. Heavy reliance is placed on published literature on domestic sheep and other genera to develop what appear to be firm conclusions. Even the extrapolation of his field data to mountain sheep behavior in the desert or in the Northwest Territories is risky due to the almost infinite variability of the environmental conditions that influence behavior.

One of the most outstanding values of the book is that it is stimulating. The reader will be swept into new channels of thought by Dr. Geist's original and refreshing discoveries and ideas. Much of what he says may be of value to the thoughtful game manager, such as his comments on traditional attachment to home ranges and the role of the heavy-horned ram in gene perpetuation. Arguments about Dr. Geist's theories, such as those on the selective forces that shape and maintain behavioral traits, will continue for years and will spark investigations designed to test and probe his postulations. But Dr. Geist seems to say, "Here's what I believe. You are challenged to prove otherwise." In the preface he states: "At present my graduate students and I are working hard to make this book obsolete."

At the very least, this is an important work about mountain sheep. It will stand for many years as the most extensive published study of mountain sheep behavior, and for that reason alone it deserves a place on the bookshelf of any biologist.

NORMAN M. SIMMONS

Canadian Wildlife Service,
Box 508,
Fort Smith, NWT, Canada

Wild Flowers of the Pyrenees

By A. W. Taylor. Chatto and Windus Ltd., London. 1971. 103 p. $6.00. Available in Canada from Clarke Irwin Co., Toronto.

This book contains a collection of 91 photographs, half in colour, of some of the more showy flowering plants found in the Pyrenees Mountains.

Each photograph is accompanied by a short description of the plant, and an indication of when and where it may be found. There is a short two-page introduction, a list of species in botanical sequence, and index of common and botanical names. The reader will recognize many genera

which are widespread in distribution even though some of the species depicted may be local endemics.

In taking the photographs, the author tried not only to capture the plants, but also to depict their habitat, and in many cases the mountainous background. In this he has succeeded rather well, except in the case of close-ups, where the background is necessarily blurred. The colour photographs are for the most part excellent. The black and white, however, leave so much to be desired that one wonders if they were not originally taken in colour.

This is the type of book which the tourist visiting the Pyrenees will be more than happy to take back home as a memento of his trip, and indeed it may help him identify some of the plants he sees while there. I question however, just why it should be jointly published in Canada. It will surely not be widely read in this country.

WILLIAM J. CODY

Plant Research Institute
Central Experimental Farm
Ottawa, Ontario
K1A 0C6

The Sea Beach at Ebb Tide

By Augusta Foote Arnold. Dover Publications, New York. 1968. 490 p. $3.50. Available in Canada from General Pub. Co., Don Mills, Ont.

In North America, particularly with reference to the east coast, the serious amateur is handicapped by the lack of accurate, comprehensive handbooks for identification of marine species. I am afraid that the re-publication by Dover Publications Inc. of Augusta Foote Arnold's "The Sea Beach at Ebb Tide" originally published by the Century Company in 1901, does little to fill this void.

The work is intended as a handbook to cover intertidal life in North America. It falls far short of its objective, and by its attempt to deal with both coasts simultaneously becomes both bulky and confusing. Relatively few species are common to the two coasts and it seems most unlikely that a person would study the two areas at once.

Geographical coverage of the two coasts is also inadequate and Canadian locations are rarely mentioned, despite the fact that they offer exceptional conditions for collectors. In fact, the work is chiefly about the New England and California coasts of the U.S.A. Concentration on the New England area is particularly noticeable in the introduction where "Collecting at Bar Harbour" receives detailed treatment, even to the extent of discussing specific rock pools. This detailed local treatment would not be so out of place had the author at least mentioned other particularly interesting locations. For example the presence of many "Virginian" species in the Gulf of St. Lawrence is ignored as are several species of northern affinities such as the arctic wedge clam, the truncate soft-shell clam and the ridged barnacle which extend well down the east coast.

Serious intertidal students will also be disappointed by the emphasis placed on a few groups, notably Crustacea and shelled Mollusca, while other groups of great interest are virtually ignored. Particularly poor are the sections on polychaetes, sponges, ascidians, amphipods and nudibranch molluscs. At the opposite extremes, there are sections on such groups as crinoids, ctenophores and cephalopods which are not normal inhabitants of the shore and are rarely collected there.

In many instances species are illustrated that are not mentioned in the text and occasionally the illustration is not the species referred to. The plates are generally of poor quality and occasionally are so bad as to be useles or misleading for identification; this is particularly true of Part I covering the algae. The illustration of *Fucus vesiculosus* the common rockweed in plate XIV is completely unrecognisable. The figures, on the other hand, are generally good and often excellent.

In summary, I feel that the value of this volume is mainly historical. As a re-publication of one of our earliest works on the natural history of the shore it holds considerable interest. Additionally the material presented is interesting and often amusing. However, this volume should not be used as a manual for identification; such use could only lead to confusion and frustration.

MARTIN L. H. THOMAS

Dept. of Biology
University of New Brunswick
Saint John, New Brunswick.

Hawks, Owls and Wildlife

By John J. Craighead and Frank C. Craighead, Jr. Dover Publications, Inc., New York. 1969. xix + 443 p. $3.95. Paperbound. Unabridged republication of the original (1956) edition published by Stackpole Company, Harrisburg, Pennsylvania.

The complex niche occupied by the birds of prey is the subject of this detailed study carried out through the 1940s, first published in 1956, and republished by Dover in 1969. By investigating the whole community of raptors in a given area, and by studying the various prey populations, the relationships between predators and prey unfolded in a manner which is only hinted at by other studies of either single predators and their prey, or a single prey species and its predators. By taking the ecosystem approach, the Craigheads managed to put the nature of raptor predation into perspective.

Inspection of the table of contents and the introduction indicates how their studies were designed, carried out, and analyzed. The fall and winter seasons are treated in the first part of the book; spring and summer in the second. The main study areas (37 sq. mi. in Michigan, 12 sq. mi. in Wyoming) and the methods are described and illustrated. Movements of raptors, their ranges, and their overall populations are computed and mapped. Hawk and owl food habits are discussed, and estimates of prey abundance and distribution are analyzed. From this, the impact of the total avian predator population upon the bird and mammal prey species are determined, and the dynamics and function of predation are elucidated. Fourteen pages are devoted to a concise summary of the main points of the 15 chapters. (See also their summary of this research in the chapter on raptors, p. 200-217 in "Birds In Our Lives", A. Stefferud, editor. 1966, U.S. Government Printing Office, Washington.)

"Hawks, Owls and Wildlife" is not dry research material. The text is quite readable, and interspersed through it are interesting observations on the behavior of raptors. Sixty-seven photographs illustrate the study areas, the techniques, the prey, and the predators, and numerous maps give the reader a feel for the study areas, the distribution and activities of the raptors and their prey. An index provides access to data in the text and in the numerous tables. The text contains a small number of errors with regard to literature citations, i.e. incorrect publication dates, omissions of a junior author's name, or omissions of the reference from the literature cited section (e.g. pp. 114, 178, 198, 312). The liberal use of headings and subheadings allows the reader to easily follow the progression of thought. By the time that predator-prey relationships are discussed, the reader can quite well understand the background data, and the significance of the main points becomes clear.

It seems most fortunate that much of the Craigheads' work on this research was conducted before the appearance of organochlorine insecticides in wildlife food chains; similar studies, if conducted today, would have these new and complex variables to grapple with.

With some North American raptors experiencing widespread declines and reproductive difficulties, and with the increasing general awareness of their problems and their role in nature, the birds of prey are receiving some more sensible management and less blanket condemnation. This book has been republished at an opportune time, when biologists and wildlife managers can make good use of these research findings on the predation phenomenon, and when many naturalists are searching for information on poorly understood and often mismanaged wildlife such as the predators.

R. WAYNE NELSON

Department of Biology,
The University of Calgary,
Calgary, Alberta T2N 1N4

The Winter of the Fisher

By Cameron Langford. Macmillan Co. of Canada, Toronto. 1971. 222 p. $6.95.

The Winter of the Fisher is a romantic tale of a fisher's first year of life. Based on fact, as the description on the dust jacket claims, the book contains nevertheless more fiction than facts. This is not really surprising because the fisher has been studied little in the field and there is a dearth of reliable observations on the species in the scientific literature.

The author's approach in relating the principal hero's experiences is mildly anthropomorphic. His fisher "grasped intuitively", "puzzles out", experiences "hopelessness", is "determined" and "hates". The story also has its share of unlikely happenings

that make the willing suspension of disbelief somewhat difficult at times. Mother fisher dispatches with lightning speed dogs at least seven times heavier than she is. Her orphaned and only surviving son — the mother and the rest of the family having been ruthlessly wiped out by the vengeful dog owner — is led away from a forest fire by a moose, takes revenge on a trapper who is out to get him and develops an almost human relationship with an old Ojibway who treats him kindly. All the necessary ingredients for a successful Walt Disney production are there, including a romance with an experienced older female.

Langford has succeeded, however, in capturing the beauty and atmosphere of the northwoods with its many interesting inhabitants very well on the pages of his novel. There is no doubt that this book, well written and often poetic in quality, will provide pleasant reading for those who like animal fiction and are receptive to the moods and picturesque beauty of nature. The person interested in learning more about the fisher will have to look elsewhere.

C. G. VAN ZYLL DE JONG

Curator of Mammals,
National Museum of Natural Sciences,
Ottawa, Canada K1A 0M8

Amphibians and Reptiles of the U.S.S.R.

By A. G. Bannikov, I. S. Darevsky and A. K. Rustamov. Moscow. 1971. 303 p., 32 colour plates, 62 figures, 119 range maps. (In Russian).

This new book is a field guide to the amphibians and reptiles of the U.S.S.R. The first four pages is a preface, and 11 to 24 an introduction to the amphibians and reptiles. From 27 to 286 is a systematic account of each species (subspecies are not included) but from 287 to 294 is a list of all the species and subspecies found in the U.S.S.R. There are also three pages of selected references and an index. The entire work is carefully planned and well laid out; the coloured plates are very good and add greatly to the book. Ten species of salamanders and 23 species of frogs are treated in the text and also are shown in the coloured plates. Seven species of turtles are described, 5 of these being illustrated in colour. Seventy-nine species of lizards and 57 of snakes are described and illustrated by the coloured plates. In all 33 species of amphibians and 143 species of reptiles are described and illustrated. The checklist of the amphibians and reptiles (287-294) lists 53 species and subspecies of amphibians, 250 species and subspecies of reptiles found in the U.S.S.R.

(An earlier work (1949) by the late Professors P. Terentjev and C. Chernov although more comprehensive lacked coloured plates and was not a field guide. Terentjev and Chernov gave descriptions for 10 salamanders, 22 frogs, 7 turtles, 63 lizards and 52 snakes).

Thus in the present work, we see an increase in the number of species recognized of frogs, lizards and snakes. Prof. A. G. Bannikov, Dr. I. S. Darevsky and Dr. A. K. Rustamov deserve much credit for providing us with an excellent field guide to the amphibians and reptiles of the U.S.S.R.

STANLEY W. GORHAM

New Brunswick Museum,
St. John, N.B., Canada

Insect Pollination of Crops

By John B. Free. 1970. Academic Press, London and New York. 544 p. $21.00.

In appraising a book that refers to more than 1600 papers and books, a reviewer must confine his assessment mostly to the portions that deal with research with which he is familiar. His assessment may therefore be somewhat biased. Although this reviewer knows of no one in the English-speaking world more qualified to write a comprehensive book on insect pollination of crops than J. B. Free, he nevertheless finds this book disappointing. Despite the huge number of references, some important ones are omitted and some unimportant ones are included. For example, the author refers to the preliminary work of a researcher published in an unrefereed, mimeogaphed booklet and ignores the later work published in an internationally-known refereed journal. Also, early papers from refereed journals are quoted and later ones on the same subject are not quoted. Many a researcher changes his interpretation of a phenomenon as he gains knowledge and experience; his later papers on a subject are, therefore, the ones that should be quoted.

Dr. Free hoped that his book would ". . . be useful to growers, plant breeders, beekeepers,

advisory and research workers, and help to provide a foundation for continued progress." To a large extent, it is doing these things. However, discussions like that on the use of solitary bees as pollinators, in which the philosophy "give the bee a place to nest" is the only one discussed, are not going to be of much help. The author does not think that the long-tongued bumblebees, which readily obtains nectar from the long corolla tubed red clover, can be managed economically because ". . . colonies in nest boxes seem more susceptible to attack than naturally occurring colonies, probably because they are more easily discovered." And yet endorses similar procedures for obtaining solitary bees for pollination purposes without discussing the need for obtaining as full control as possible over the bee in order to protect it from weather and enemies.

The bias to which this reviewer referred at the beginning of this assessment probably results from his using as a basis the few chapters on work with which he is familiar — those on utilizing wild bees as pollinators and on certain of the papilionaceous crops. He found the information on other crops in other chapters, for example, the Cruciferae, most informative. He is therefore thankful to have a volume to which he can turn for information on all of the insect-pollinated crops that he is likely to encounter.

G. A. HOBBS

Canada Dept. Agriculture Research Station
Lethbridge, Alberta, Canada.
T1J 4B1

How to Know the Marine Isopod Crustaceans

By George A. Schultz. Wm. C. Brown Co., Dubuque, Iowa. 359 p. $5.50 cloth, $4.50 paper.

With the explosive interest in ecology in recent years there has been a corresponding need for reference manuals to aid in the identification of animals and plants. The situation is particularly critical for marine studies where most of the references on invertebrates are out of date and unavailable. The Pictured Key Nature Series is one of several attempts to fill this gap.

The present volume with 359 pages is one of the largest in the series. It attempts to cover almost all of the species found in North American waters (i.e. north of Panama). Although there have been some regional works and monographs on particular groups, this is the first comprehensive list and key since the "Monograph on the Isopods of North America" by H. Richardson published in 1905. It is therefore a very useful up to date account of the North American species.

Unfortunately the author has apparently relied only on the North American literature, with the result that there are some notable weaknesses. Thus it is disappointing to find the genus *Jaera,* whose members are among the most frequently encountered intertidal forms on the northeastern coast, listed as *Jaera marina* rather than the six species that have actually been reported.

The book is well produced with adequate keys and illustrations, and is reasonably priced. It can be recommended with reservations for general identifications of these interesting animals.

D. H. STEELE

Department of Biology
Memorial University of Newfoundland
St. Johns, Newfoundland.

The Lives of Wasps and Bees

By Sir Christopher Andrewes. American Elsevier Publishing Company Inc., New York. 1971. 204 p. 16 plates. $6.50.

As each new book appears, its need is likely to be questioned by someone. So it was with this one on bees and wasps because there are two dozen or more that have preceded it. On reading the accounts on the lives of these facinating insects, it soon became very evident that there was a need for a book of this type. In it, the biology of the wasp and bees is presented briefly in such a manner as to enlighten and excite both the beginner and the dedicated 'wasp-watchers'.

The chapters are arranged so that one follows the supposed evolutionary development of behaviour patterns from the simple to the complex and can see clearly that the degree of specialization or lack of it is not restricted to any one family. The examples used were selected from representatives of the fauna of Great Britain, Continental Europe, and North America, with a

few from Asia, Africa, and the tropical regions. Such a selection serves to illustrate one of the aims of the book, to stimulate interest in these insects by pointing out how little is known. When one considers that the book deals with about 175 species from 90 genera and realizes that there are over 400 species in Britain and about 400 genera in North America the challenge issued the author is an exciting one.

The author provides a guide to the pronunciation of the scientific names, a skeleton classification, and the general distribution of these insects. For the beginner, especially, these are very necessary. Unlike some of the animals of the world for which there are common names, few of the bees and wasps can be so identified. The host species of the wasps is provided as are the more common parasites or predators. More detailed information can be found by referring to the sixty-one books and articles listed near the back of the book.

There are a few typographical errors, some of which may be confusing to the beginner. On page 63, the last paragraph begins "A genus of bees similar to *Philanthus* is called *Cerceris*". Both of these of course are wasps. There are a few instances where scientific names have not been italicized e.g., page 131, line 32 *S. subquadratus;* page 147, line 3 *Bombus;* line 10 *Halicti;* page 155, line 34 *Bombi;* page 156, line 24 *Bombus*. The main point is that the reader should realize that these have the same taxonomic status as those that are italicized. On page 186, line 18, the sentence is a little confusing and perhaps the last word in the sentence should be 'genus' rather than 'genera'.

Aside from these minor points, the student of wasps and bees has a valuable source book and a place to begin. As stressed by the author in his opening paragraph, the leisure time of the future for some people can be filled in the most rewarding way through a study of living things, not the least of these being the wasps and bees. For those who would like to delve into the secrets of these insects, this book will be invaluable.

D. H. PENGELLY

Dept. of Environmental Biology
University of Guelph
Guelph, Ontario.

The Classification, Evolution and Dispersal of the Winter Stonefly Genus *Allocapnia*

By Herbert H. Ross and William E. Ricker. Illinois Biological Monographs No. 45, University of Illinois Press, Urbana, Ill. 1971. 166 p. 111 figures. $8.95.

The winter stoneflies of the genus *Allocapnia* are restricted to Eastern North America. Since most species have somewhat degenerate wings, they are incapable of sustained flight and have a limited ability to disperse. Their present distribution patterns can thus be used to infer their past faunal movements and particularly their postglacial dispersion.

But before a zoogeographical account could be undertaken, the authors had to revise the taxonomy of the group. Their report is presented in five major sections: phylogenetic position of *Allocapnia,* systematic treatment, phylogeny, geographical dispersal, and finally dispersals and time.

The phylogenetic position of the genus within the Capniidae is discussed shortly and the conclusions are clearly summarized in a phylogenetic tree. The most interesting point is that *Allocapnia* is seen as an offshoot of the large genus *Capnia*. It is unfortunate that the diagram is incomplete because many of the Asiatic genera, and in particular the *Allocapnia*-like *Takagrypopteryx* from Japan, have not been included. The authors have also given little precision concerning the material they studied in each species group beyond the vague "species known to us". Furthermore there seems to be a few errors: *Isocapnia* and *Eucapnopsis* are indicated as Eurasian and *Nemocapnia* as North American, while all three, to my knowledge, are holarctic.

The systematic treatment is thorough and exhaustive; 38 species are described in detail, four of which are new. Keys are presented to separate the males of all the species and most of the females; males of known hybrids are also included. The drawings of diagnostic characters are very nicely done and extremely precise and illustrative. For each species, a detailed distribution map is given.

The phylogeny is discussed at length. A hypothetical ancestor is reconstructed and a sequence of the apparition of the various species-groups is presented. The evolution of the species within each group is then outlined. Although the scheme of evolution is based primarily on the males,

female characteristics ordinarily confirm the conclusions.

The phylogeny is then correlated with the probable dispersal patterns within each group.

In a final chapter, an attempt is made to correlate the evolutionary and zoogeographical processes with known geological events and chronology.

The book is well edited, it contains few typographical errors and the numerous illustrations are clear and informative. The authors must be congratulated for an excellent taxonomic revision which will be useful to all entomologists and freshwater biologists interested in stream fauna. The sections on evolution and dispersal are presented objectively and all the available evidence has been seriously weighed before the conclusions were reached.

The great accumulation of data will make this book particulary interesting to students of zoogeography and evolutionary processes; they will find enough of the basic information, both morphological and zoogeographical, to weigh the evidence with objectivity and reach their own conclusions.

P. P. HARPER

Département des Sciences Biologiques
Université de Montréal
Montréal, Québec

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Compiled by Stanley M. Teeple

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